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KAILAN MINING ADMINISTRATION.

MEMORANDUM

BY

MAJOR W. S. NATHAN

ON

SCHEME FOR IRON WORKS ETC., AT CHINWANGTAO.

22nd DECEMBER, 1920.

Waterlow and Sons Limited, London Wall, London.

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KAILAN MINING ADMINISTRATION.

On the 30th June I submitted a report on the progress made with regard to the various schemes under consideration for the improvement of the methods now in use of coal washing and coke producing, and for the erection of blast furnaces.

The information now collated is fairly complete, both as regards technical detail, and costs, with the exception of the cost of the blast furnace plant. With regard to this latter, great delay has been experienced in obtaining the necessary detailed specifications and drawings to enable tenders to be called for from suppliers, and at the time of commencing the drafting of this report they are still not available. Rather than delay its preparation therefore I am basing the costs of the blast furnace plant on estimates supplied by Mr. Roberts, the designer, checked by our Consulting Engineer, Mr. Harbord. These estimates are based on the current price of labour and material, and all expenses to be incurred in China have been carefully gone into by Mr. Docquier and Mr. McConaghy, and I do not think that, supposing tenders had been received, they would have been found to differ to any great extent from the figures now presented.

It must be borne in mind that the present estimates have been framed at a time when the cost of material was nearly at its highest point and that the tendency of prices since has been uniformly downward, a tendency which is generally thought will be maintained. Under these circumstances, it seems likely that the estimates, generally speaking, will be found considerably on the conservative side. The estimates for all the other plants have also been made out on a high priced material basis, and considerable saving may be expected. The costs of the coking, by-product recovery and sulphuric acid plants are based on the actual tenders already received, to which have been added the various works necessary to be carried out in China. The cost of all subsidiary works such as power house, railway lines, rolling stock, etc., has been based either on actual quotations received, or by comparison with work and supplies already carried out or obtained.

I believe that the estimates are considerably in excess of what the actual expenditure will be, principally owing to the fact that the value of material is already less than estimated for. For

example, since the estimate for rails, which is an important item, and which have been calculated at £25 per ton, a quotation has been received from Brussels giving the price of smaller quantities at £19 per ton, with a reduction for larger quantities. Liberal allowance has also been made for foundations owing to the fact that it has not been definitely decided whether piling will be necessary or not. It seems probable that the only pile foundations to be required will be under the blast furnaces and hot stoves, and it is even possible that, on further examination, these may prove unnecessary.

I propose to deal in this report with each item of the works in the same order as in my report of the 30th June, but changing the different items to get a better sequence and to provide for more definite description. The headings will be as follows :—

1. General works common to more than one of the schemes.
2. Washing plant.
3. Coke ovens.
4. By-product recovery plant.
5. Sulphuric acid factory.
6. Blast furnaces.
7. Alterations and additions to brick making plant

It will be noted that I have omitted from the items the Low Temperature Carbonization Works. In my report of the 30th June, I stated that the question is not one calling for an early decision and that long and careful study would be necessary before any decision could be come to. As I then stated, I find great divergence of opinion in the matter, and I also find that much experimental work is now being carried out in England and elsewhere which should, after a period, make it much easier to decide, both on the system to adopt and the general design and lay-out of such works. I regret that up to the time of writing this report the results of the tests on our coal, undertaken by Sir George Beilby, at the Government Research Plant, have not come to hand, but I have received a report from Dr. Colman, which I attach as an addenda to this report, from which it will be seen that our coal is a very difficult one to carbonize at low temperature. I anticipate that Sir George Beilby's tests will be still more unfavourable, as the system used by him is one which is likely to prove the least adaptable to our coal. Under the circumstances, and in view of the limited time at my disposal, I do not propose to proceed further in the matter myself, but will place the consideration of the problem in the hands of our Consulting Engineers to study, and eventually to prepare a scheme on my return to England. I am somewhat reluctant to give up the immediate consideration of this matter as I feel that by doing so I am continuing the antiquated method of using our coal directly under the boilers and thus losing a considerable quantity of by-products which will prove so valuable to us. Another reason for regretting the delay

in this matter is that I find it will be absolutely necessary, for the manufacture of bricks for our coke and blast furnace plant, to utilize gas-fired kilns, and instead of obtaining gas from the low temperature carbonization plant, we must instal gas producers fed by coke manufactured at the Mines. In the near future, I hope to prepare a project for the manufacture of coke in a small modern coking plant with by-product recovery, the gases from which would be utilized to fire the boilers at some of the mines, and also to furnish gas to the brick kilns. The coke would be disposed of in the local market, which up to the time of the installation will still require to be supplied from the Chinese beehive ovens now in use.

GENERAL.

I attach to this report two plans:—Plan No. 1, showing the general position of the various plants, with railway communication, etc.; Plan No. 2, giving a more detailed idea of the lay-out of the coke ovens and blast furnaces, also showing the arrangements made for future developments, if required.

On these plans and in the estimates, provision has been made for railway connection on a scale which will adapt itself later to all increases in the plant likely to be required.

The area of ground between the Tangho River and the line from the Chinese Government Railway to the Breakwater has been found amply sufficient for all purposes, including any probable future extensions.

I should like to point out that the various schemes now projected are not designed with a view merely to provide for the blast furnace plant. The washing plant is only a replacement of the present plant at Linsi, somewhat enlarged to make provision for the coke required for the blast furnaces. The present plant at Linsi which, after some years of trial, has been found inadequate, will be gradually replaced, the old plant being retained to furnish washed coal for local requirements in Tientsin, Peking, and other districts which, in view of the long rail haulage, it would be very expensive to supply from Chinwangtao. It must also be remembered that one of the main reasons for transferring the washing plant to Chinwangtao is that the railways have suffered great loss and inconvenience from carrying wet coal after washing, considerable damage having been done to the permanent way and rolling stock, owing to somewhat acid water falling on the axle boxes and rails.

Similarly, the coking plant is the substitution of modern methods with by-product recovery, for the crude system of Chinese beehive ovens, extravagant in the consumption of coal and wasteful of all the products of combustion.

Both washing and coking plants would have been necessary even if the blast furnaces had not been decided on, the latter merely necessitating an increase in the output of both.

Examining the different items of the scheme in the order set forward on page 4 of this report :—

1.—GENERAL WORKS COMMON TO MORE THAN ONE OF THE SCHEMES.

The works, with their estimated cost, to be carried out under this head, are as follows :—

		£
(*a*) Preparation of site	~~£20,000~~	10,000
(*b*) General offices	~~10,000~~	5.000
(*c*) Laboratory	~~4,000~~	2,000
(*d*) Bungalows and coolie lines	~~27,000~~	13,500
(*e*) Workshops	~~10,000~~	5.000
(*f*) Roads	~~4,000~~	2.000
(*g*) Lighting	~~10,000~~	7.500
(*h*) Stores	~~6,000~~	3.000
(*i*) Railway from subway to hills near Tangho	~~130,000~~	102.865
(*j*) 36 thirty-ton cars	~~54,000~~	52.000
(*k*) 4 locomotives	~~44,000~~	42.000
(*l*) Railways from junction to the various plants	~~65,000~~	55.000
(*m*) Ten-ton locomotive crane	~~12,000~~	12.000
(*n*) Main transmission line	~~10,000~~	5 000
(*o*) Stone crusher and mortar mills ...	~~6,000~~	5 625
(*p*) Water supply	~~32,500~~	26 250
(*q*) Power plant	~~180,000~~	170 350
Total	~~£624,500~~	£519.090

(*a*) *Preparation of Site.*—This item includes only the site for the coke ovens and blast furnaces, the site for the washing plant being considered separately.

As in most of the general expenditure it is difficult to apportion the amounts required to each plant, I have divided the expenditure equally between the different plants concerned.

The expenditure under this heading will be incurred in raising and levelling the ground actually required for the coking and blast furnace plants. The site itself stands somewhat low and would be liable at times to flooding from the River Tangho. It is therefore proposed to utilize the sand dunes to the east of the site to raise the level of the ground to a minimum height of 5 feet above high water level on the coast.

(*b*) *General Offices.*—This item provides for the offices it will be necessary to construct for the technical staff, to control the disposal of output under the direction of the Head Office at Tientsin, and to house the necessary accountant staff of the works.

(*c*) *Laboratory.*—It will be necessary to carry out continual analyses of both the iron and coke produced, in order to maintain a careful check on the results of working the plants.

(*d*) *Bungalows and Coolie Lines.*—The staff required under the proposed scheme will be :—

1 general manager.
1 chief engineer.
1 chemist.
1 manager of coal washing plant.
1 manager of coke oven plant.
1 manager of blast furnace plant.
6 foremen and skilled workers for coke oven plant.
12 foremen and skilled workers for blast furnace plant.

It is proposed to utilise the present bungalows at Creek View, the seaside resort, to house the staff, in preference to building new quarters. This will involve the loss of a certain amount of revenue from letting these bungalows for the summer months, but, financially, they have not been any very great success, and the cost of building new quarters would be very considerable. The site is somewhat distant from the works, but with good roads and one or two motor cars, it is considered that the work carried out by the staff will not be hampered by the distance, and that, on the other hand, more healthy surroundings and the separation of the staff from the works when off duty will be an advantage. Not much will be required to be done to the houses themselves except the laying on of water. I have allowed a sum of £5,000 for this purpose.

It has been estimated that besides the foreign staff, 400 Chinese foremen and artificers and 800 Chinese labourers will be employed on the works. These will therefore require accommodation. I provide for the former at a rate of £40 and for the latter at £6 each, making the total cost of providing accommodation as follows :—

Alteration and water supply at Creek View	~~£5,000~~	2.500
400 quarters for Chinese at £40 each ...	~~16,000~~	8.000
800 „ „ „ „ £6 „ ...	~~4,800~~	2.400
Widening of a culvert and raising of site...	~~1,200~~	600
Total ...	£27,000	13.500

(*e*) *Workshops.*—These will be for the general use of the whole plant and will to a certain extent replace the existing shops at Chinwangtao, which will be used as locomotive and wagon repair shops only.

(*f*) *Roads.*—It will be necessary to construct a good macadamized road between Creek View and the works, also good interior communications in the works themselves.

(*g*) *Lighting.*—This item provides for the electric light installation in the works themselves. The power for this lighting will come from the central power station provided for separately in the estimates.

(*h*) *Stores.*—These will be of a general nature, providing for the coke and blast furnaces plants.

(*i*) *Railway from Subway to Hills near Tangho.*—This very considerable item in the estimate would be necessary for the new harbour works at Chinwangtao, independent of the blast furnace installation. Its object is to connect with the limestone deposits in the hills near the old Tangho Station of the Chinese Government Railways. It must be remembered that the main railway has been lately diverted from Tangho Station to pass through the port of Chinwangtao.

The limestone is required for the filling and concrete work of the new breakwater, for all permanent stone and concrete work to be carried out at the port, and for the supply of flux for the blast furnaces. It will also be required in considerable quantities for the concrete work in the foundations of the new plant.

The length of line will be approximately twelve miles. It has been considered desirable that the line should be laid over the existing Decauville track now being used by the Liu Chiang Mining Company for the conveyance of their anthracite coal to Chinwangtao. The expense will be slightly less than taking a direct line from the works, which would not be appreciably shorter.

The limestone deposits are situated some four miles from the present rail head, and new embankments, etc., will be required over this length, including a bridge over the Tangho River.

At the present time the railway is leased by the Kailan Mining Administration to the Liu Chiang Mining Company. This lease will have to be rescinded, which, as the Mining Company will derive considerable benefit by the substitution of a normal for a narrow gauge railway and save considerable handling and other charges, there will not be any difficulty in arranging. A distinct advantage will accrue from the fact that we shall be able to earn a revenue from the carriage of the anthracite coal over our line.

The estimate provides for the rolling stock necessary for our traffic.

(*j*) 36 *Thirty-ton Cars.*—These cars will be required for the carriage of material about the works and to the loading berths. They will also be utilisable for general traffic when required.

(*k*) 4 *Locomotives.*—These will be necessary for the increased traffic, due to the new plant.

(*l*) *Railways from Junction to the Various Plants.*—This sum is large, but a glance at the plans will show the necessity for making ample provision for this item.

The traffic in such works as proposed is very complicated and it is desirable to lay ample siding accommodation, and to facilitate the rail traffic by as good a lay out as possible.

It is estimated that twelve miles of track will be required.

It must be remembered that this initial outlay will be sufficient to meet the demands of future extensions with little extra expenditure, and the only extra work required will be to prolong sidings into the plants as they become extended.

(*m*) 10-*ton Locomotive Crane.*—This will be required for the shifting of heavy pieces of machinery, etc., which would be very costly to handle except by this means.

(*n*) *Main Transmission Line.*—This provides for the transmission of electric power from the central power station to the various works.

(*o*) *Stone Crusher and Mortar Mills.*—This item calls for no special remark.

(*p*) *Water Supply.*—In works such as are contemplated for Chinwangtao the question of a sufficient water supply is of great importance. I give below the actual requirements for the various Plants :—

	In circulation per 24 hours. Gallons.		Loss per 24 hours. Gallons.
Blast Furnace and Power Plant, if Fresh Water only is used :			
Boiler evaporation ...	201,600	Wastage 20% —	40,320
Bosh cooling ...	1,598,400	„ „ —	319,680
Condensing water for Power Plant and Blowing Engines	12,096,000	„ „ —	2,419,200
Washing Plant	1,008,000	... ... —	87,750
Coke Oven Plant ...	550,000	... ... —	175,000
TOTAL	15,454,000	... ... —	3,041,950

The main source of water supply is the River Tangho. During last hot weather a remarkable drought has been experienced in this part of China, as witnessed by the famine conditions now existing in the neighbourhood. During this period a careful estimate of the flow of water in the Tangho has been made and the minimum yield per 24 hours has been found to be 1,959,552 gallons, or, in round figures 2,000,000 gallons. Besides the actual flow there is a considerable sub-soil flow in the river and also a considerable mass of water at a short distance below the surface of the ground in the neighbourhood. What is likely to be the yield from the last two sources is not at present determined, and can only be estimated when the water works now contemplated are in working order. For the purpose of this estimate, only the supply from the usual flow of the Tangho River has been considered.

It is obvious that at times of great drought the supply from the river surface flow will be insufficient to meet requirements. Under these circumstances, it may be necessary to use sea water for a part of the installations, and this requirement has been allowed for in the estimates. Salt water would be used entirely for condensation at the power plant

and blowing engines, thus reducing the total wastage of fresh water by 2,419,200 gallons per 24 hours, leaving the total daily requirements of fresh water at 622,750 gallons. It will be seen therefore that the flow of water in the Tangho, if necessary reinforced by salt water, will be amply sufficient for the requirements of the present scheme. It seems likely that when the other sources of supply mentioned above are tapped, that a very greatly increased volume of water will be obtainable.

The experience gained by the new works will easily show whether a supply sufficient for the future developments contemplated, including the steel works, is available, or whether it will be necessary to obtain another source of supply, either from the Shanhaikuan river or by constructing a reservoir at the foot of the hills near Tangho.

(*q*) *Power Plant.*—The question of power required for the supply of electricity to the new Plants, as well as for the present supply for the port of Chinwangtao, has been carefully gone into. It has been decided that it will be necessary to instal a Plant capable of producing 4,000 kilowatts. The Plant will consist of:—

	£
2 Babcock and Wilcox boilers of 666 square meters working at 225 lbs. per sq. in. pressure and 200 superheat, complete with accessories, superheaters, induced and forced draught fan and steel chimney	30,000
2 Two-thousand kilowatt Turbo-Alternators, complete	40,000
Switchboard and cables	10,000
Piping	10,000
Cooling Tower	5,000
Cranes, etc.	5,000
Freight and import duty	15,000
Foundations, buildings, erection and labour for a building 200 ft. × 60 ft. × 55 ft.	55.350 ~~65,000~~
	~~£180,000~~ 170.350

The estimates are based on present prices for this class of machinery, of which we have recently had considerable experience in connection with the increase of Power Plant at Linsi.

2.—WASHING PLANT.

In my report of the 30th June, 1920, I went fully into the question of the washing of our coals. For the sake of completeness, I think it desirable to repeat the full text of my report of that date.

Coal Supply.

As far as possible it is desirable, owing to the lower cost of transportation, to use coal from the Mines near Kuyeh Station, namely:—Linsi, Chaokochwang, and later on when available, Tang Chia Chwang.

Not all the coals from these Mines are capable of satisfactory washing and it will therefore be necessary to select the most suitable seams for washing and to make up the total amount required from other Mines, principally from Machiakow.

The coal to be used and the quantities available will be as follows :—

Chaokochuang 9 Seam.—The total production from this seam will be taken at 2,700 tons per diem, of which 1,700 tons will be Slack giving the following amounts under different sizes :—

1 in. to $\frac{3}{8}$ in.	...	...	425 tons per diem.
$\frac{3}{8}$ in. to $\frac{3}{16}$ in.	...	...	255 „ „
$\frac{3}{16}$ in. to 0 ...	...	...	1,020 „ „

From this seam will be obtained 425 tons per diem of unwashed nuts and 1,275 tons per diem of coke-making coal.

Chaokochwang 8 Seam.—The total production from this seam will be taken at 1,950 tons per diem, of which 1,710 tons will be Slack giving the following amounts under different sizes :—

1 in. to $\frac{3}{8}$ in.	..	...	295 tons per diem.
$\frac{3}{8}$ in. to $\frac{3}{16}$ in.	...	...	175 „ „ „
$\frac{3}{16}$ in. to 0	...	...	700 „ „ „

From this seam will be obtained 295 tons per diem of unwashed nuts and 875 tons per diem of coke-making coal.

Chaokochwang 12 seam—Roof.—The total production from this Seam will be taken at 975 tons per diem of which 585 tons will be Slack giving the following amounts under different sizes :—

1 in. to $\frac{3}{8}$ in.	...	...	145 tons per diem.
$\frac{3}{8}$ in. to $\frac{3}{16}$ in.	...	...	90 „ „ „
$\frac{3}{16}$ in. to 0	...	...	350 „ „ „

From this seam will be obtained 145 tons per diem of unwashed nuts and 440 tons of coke-making coal.

The remaining coal of the Chaokochwang Mine, which is superior and will probably be used for other purposes, will not be therefore considered.

The coal to be expected from the Chaokochwang Mine as passing to the washing plant, will therefore be :—

(425 + 295 + 145) = 865 tons unwashed nuts = 650 tons washed nuts.

(1,275 + 875 + 440) = 2,585 tons unwashed slack = 1,940 tons washed slack for coke-making.

Linsi 9 Seam.—The total production from this seam will be taken at 1,600 tons per diem, of which 1,200 tons will be Slack giving the following amounts under different sizes :—

1 in. to $\frac{3}{8}$ in.	...	...	300 tons per diem.
$\frac{3}{8}$ in. to $\frac{3}{16}$ in.	...	...	180 „ „ „
$\frac{3}{16}$ in. to 0	...	...	720 „ „ „

From this seam will be obtained 300 tons per diem of unwashed nuts and 900 tons per diem of coke-making coal.

Linsi 11 Seam.—The total production from this seam will be taken at 600 tons per diem, of which 450 tons will be slack, giving the following amounts under different sizes :—

1 in. to $\frac{3}{8}$ in.	...	...	110 tons per diem.
$\frac{3}{8}$ in. to $\frac{3}{16}$ in.	...	...	70 „ „ „
$\frac{3}{16}$ in. to 0	...	...	270 „ „ „

From this seam will be obtained 110 tons per diem of unwashed nuts and 340 tons per diem of coke-making coal.

The balance of coal from Linsi will not be considered, part (5 seam) being used for special purposes and the balance being considered unwashable.

The coal to be expected from the Linsi mine as passing to the washing plant will therefore be :—

(300 tons + 110 tons) = 410 tons unwashed nuts = 300 tons washed nuts.

(900 tons + 340 tons) = 1,240 tons unwashed slack = 930 tons washed slack for coke-making.

Machiakow. All Seams.—The total production of this mine will be taken at 3,000 tons per diem, of which 2,250 tons will be slack, giving the following amounts under different sizes :—

1 in. to $\frac{3}{8}$ in.	...	...	560 tons per diem.
$\frac{3}{8}$ in. to $\frac{3}{16}$ in.	...	...	340 „ „ „
$\frac{3}{16}$ in. to 0	...	...	1,350 „ „ „

From this mine can therefore be obtained :—

560 tons unwashed nuts, giving ~~1,270~~ 430 tons of washed nuts per diem.

1,690 tons unwashed slack, giving 1,270 tons of washed slack per diem for coke-making.

All coal from other mines will be considered as necessary for the general market and not to be treated in the washing plant. The total production from the sources considered above are :—

Chaokochwang :

	Tons per diem.		Tons per diem.
Unwashed Nuts...	865	Washed Nuts...	650
„ Slack	2,585	„ Slack	1,940
Linsi :			
Unwashed Nuts ...	410	Washed Nuts...	300
„ Slack...	1,240	„ Slack	930
Machiakow :			
Unwashed Nuts ...	560	Washed Nuts...	420
„ Slack...	1,690	„ Slack	1,270
	7,350		5,510

The coal passing to the washing plant from these sources may amount to 7,350 tons, of which 1,835 tons will be nuts 1 in. to $\frac{3}{8}$ in. and slack $\frac{3}{8}$ in. to $\frac{3}{16}$ in., giving us products of 1,370 tons of washed nuts for the market and 4,140 tons of washed slack for coke-making purposes.

Estimate of Output required for Washing Plant.

Generally speaking the washing plant will be required for washing coal for the following purposes:—

(i). For the new blast furnaces at Chinwangtao.
(ii). For the usual sales of coke for the market.
(iii). For coal sent to Japan and Korea for coke-making purposes.

(i). *For the new Blast Furnaces.*—The blast furnaces will be designed for an immediate output of five hundred tons per day of pig iron. To produce this, 600 tons of coke will be required, and, allowing for breeze and wastage at 10%, the actual amount to be provided will be 660 tons. For this, a quantity of 924 tons of washed coal, or 1,230 tons of unwashed coal, will be required.

(ii). *For usual Coke Sales.*—During the year 1918-19 the sales of coke amounted to 40,000 tons, and the figure shewed practically no increase over the preceding year. It will be as well, however, to allow for a production of 60,000 tons per annum, any extra production over requirements being easily saleable at reduced prices. The daily output of coke for sale will be 165 tons. Allowing for breeze and wastage, 10%, the output of the ovens will be, say, 180 tons per day. For this quantity, 250 tons of washed or 330 tons of unwashed coal will be required.

(iii). *For Coal sent to Japan and Korea.*—It is difficult to estimate the amount of coal to be washed for the Japan and Korean markets as many changes may occur before the plant is erected. For example, the Edamitsu Iron and Steel Works have informed me that they will probably require an extra 800,000 tons per annum from us in about a year's time. It is not desirable to provide for quantities like this in the new plant, as the cost of the extra installations will be very considerable, and it would be a mistake to incur such expenditure until more definite information is available.

In designing the washing plant, all arrangements must be made to enable us to extend the factory quickly and conveniently.

For the present, the actual demand only will be considered.

The sales of coal in Japan for coke-making purposes in the year 1917-18 amounted to nearly 380,000 tons, and in 1918-19 to 360,000 tons. I will therefore consider that it will be necessary to ship 400,000 tons of washed coal per annum to that country. In Korea the only considerable consumption of coal for coke-making purposes is that of the Kenjiho Iron and Steel Works, who have a long period contract of 120,000 tons per annum with us. This is insufficient for their present requirements, and this year they have a contract for an extra 70,000 tons with us. I will

therefore assume that the requirements for Korea will be 200,000 tons of washed coal, making, with the Japanese sales, a total of 600,000 tons of washed, or 800,000 tons of unwashed coal per annum, or, say, 2,200 tons per diem, giving 1,650 tons of washed coal per diem.

The total amount of unwashed coal required to be sent to the washing plant for coke-making purposes will therefore be :—

For the blast furnaces at Chinwangtao ...	1,230	tons per diem.
For ordinary coke sales ...	330	„ „ „
For Japan and Korea ...	2,200	„ „ „
Total	3,760	

producing 2,820 tons per diem of washed coal.

I have already shown that the coal available for the washiug plant from the Chaokochwang, Linsi, and Machiakow mines, is capable of giving 4,140 tons of washed slack for coke making. Under these circumstances it will not be necessary for the present to take any supply of coal from Machiakow, and the following will therefore be the coals and the resulting products considered in the present scheme :—

	Unwashed coal to be treated. tons per diem.	Washed Nuts produced. tons per diem.	Washed Slack produced. tons per diem.
Chaokochwang ...	3,550	650	1,940
Linsi	1,650	300	930
Total	5,200	950	2,870

Of this coal, 1,650 tons washed slack per diem will be shipped direct from washing plant to Japan and Korea, and 1,220 tons washed slack per diem will be sent to the coke ovens for converting into coke for the blast furnaces and general market.

It will be seen from the above that the washing plant will be required to wash 5,200 tons of coal per diem and the coking plant will convert 1,220 tons of coal per diem into coke.

Coal to be used in Washing Plant and Results under Draper System.

Chaokochwang 9 seam, 8 „, 12 „ } Considered as ordinary slack.

Out of every one ton of coal, 69·94% is recovered washed ; of this

17·26 per cent. is $\frac{3}{16}$ in. to 8 with 15·40 per cent. of ash
19·04 per cent. is 8 to 16 with 12·90 per cent. „ „
19·84 per cent. is 16 to 30 „ 14·00 per cent. „ „
13·80 per cent. is 30 to 0 „ 15·40 per cent. „ „

Average percentage of Ash in washed coal will therefore be 14·32.

Linsi 9 Seam :—Out of one ton of coal, 76·21 per cent. is recovered washed ; of this

11·12	per cent.	is	$\frac{3}{16}$	in.	to	8	with 11·7	per cent. of Ash.
26·23	,,	,,	8	,,	16	,,	12·2	,, ,,
13·86	,,	,,	16	,,	30	,,	9·6	,, ,,
25·00	,,	,,	30	,,	0	,,	13·2	,, ,,

Average percentage of Ash in washed coal will therefore be 11·35.

Linsi 11 seam :—Out of one ton of coal, 85·53 per cent. is recovered washed ; of this

21·48	per cent.	is	$\frac{3}{16}$	in.	to	8	with 11·50	per cent. of Ash.
21·48	,,	,,	8	,,	16	,,	12·30	,, ,,
23·82	,,	,,	16	,,	30	,,	11·50	,, ,,
18·75	,,	,,	30	,,	0	,,	11·50	,, ,,

Average percentage of Ash in washed coal will therefore be 11·80.

If the coal for the washing plant is therefore taken from Chaokochwang and Linsi mines only, and is treated by the washing plant, the following results will be obtained :—

Output from Chaokochwang 8, 9 and 12 seam (roof), 2,590 tons per day.

Recovery—69·94 per cent. = 1,811 tons with 14·32 per cent. of Ash.

Output from Linsi 9 seam—900 tons per diem.

Recovery—76·21 per cent. = 682 tons with 11·35 per cent. of Ash.

Output from Linsi 11 seam—340 tons per diem.

Recovery—85·53 per cent. = 291 tons with 11·80 per cent. of Ash.

Total output will therefore be 2,784 tons with 13·34 per cent. of Ash.

If, therefore, the Draper system were to be adopted, there will be a deficiency of washed coal of 2,820 — 2,784 = 36 tons per diem. This deficiency is so small that it need not be considered.

Coal to be used in Washing Plant and Results under the Minerals Separation System.

Chaokochwang 9 seam, 8 ,, 12 ,, } Considered as ordinary slack.

Out of every one ton of coal, 71·7 per cent. is recovered washed, with an Ash percentage of 14·2.

Linsi 9 Seam :—Out of every one ton of coal, 81·7 per cent. is recovered, with an Ash percentage of 12·4.

Linsi 11 Seam :—Out of every one ton of coal, 84·7 per cent. is recovered, with an Ash percentage of 12·4.

If the coal for the washing plant is therefore taken from the Chaokochwang and Linsi Mines only, and is treated by the flotation principle, the following results will be obtained :--

Output from Chaokochwang 8, 9 and 12 seam (roof) = 2,590 tons per diem.
Recovery—71·7 per cent. = 1,857 tons per diem with 14·2 per cent. of Ash.
Output from Linsi 9 seam—900 tons per diem.
Recovery—81·7 per cent. = 735 „ „ „ , with 13·5 per cent. of Ash.
Output from Linsi 11 seam—340 tons per diem.
Recovery—84·7 per cent. = 288 „ „ „ , with 12·4 per cent. of Ash.

Total output will therefore be 2,880 tons, with 13·82 per cent. of Ash.

If, therefore, the Flotation system were to be adopted, there will be a surplus of 2,880 — 2,784 = 96 tons per diem.

COAL WASHING INSTALLATIONS.

The problem with regard to the washing of our coal is undoubtedly the most difficult with which we are faced.

Most of the coals so far being washed in Europe and America are more or less easily treated, the impurities being for the most part separate from the coal and thus easily removed by specific gravity. In our case, however, a large proportion of the impurities are intimately mixed with the coal, and it is only possible to get rid of them by washing away those particles in which they preponderate over the coal. It is obvious therefore, as a result, that a considerable quantity of the coal must be washed away with the impurities, and also that a proportion of the latter must remain in the washed product. The whole problem becomes one of degree as to what is the most economical and advantageous result to arrive at, that is, to what extent the cleanliness of the washed product justifies the loss accruing from allowing too much of the material to be wasted.

Our experience with the Baum Washer, which may be said to be an unscientific and rough method of treatment, has shown that it is unsuitable to our purpose, and that all systems of jig washing will be equally so.

This has led us to consider what other methods can be employed and we have now come into touch with two processes, both of which offer advantages over the old systems, but which have, so far, been employed only to a limited extent and are, in effect, not much beyond the experimental stage. As a consequence it has been necessary to carefully watch experiments with our coal under treatment by both processes. As a result of these experiments we have come to certain conclusions which I record below.

The processes are the Draper system, and the Flotation system of the Minerals Separation Company.

The Draper system consists of a series of tubes into the top of which the coal, with water, is poured. This stream of coal and water is met in the tube by an upward stream of water, the velocity of which can be regulated as required. The particles of higher specific gravity in the upper stream will disengage themselves and falling through the rising column, will be collected at the bottom of the tube and drawn off as waste ; the lighter particles will be carried away with the overflow of the tube and constitute the washed coal. By regulating the velocity of the upward column of water, it is practicable to take away any proportion of the total coal injected into the tube ; the lower the velocity the purer the coal and the greater the waste. It is therefore obvious that by this system the purity of the coal can be regulated within a considerable range at will, and it is only necessary to determine the economic value of the cleanliness of the coal compared with the amount of waste, to arrive at the results required to be obtained.

The Flotation process consists of churning the coal in water to which a small proportion of oil is added. The less pure ash or mineral matter tends to fall through the cistern, while the purer coal, becoming attached to the small bubbles in the water, floats on the top in a froth and is carried over the edge of the cistern, forming the washed product. The degree of cleanliness of the product is determined by the number of cisterns through which the coal is passed, the first carrying only a proportion of the cleaned coal, the second a smaller proportion, and so on. The size of the particles to be washed is determined by the nature of the coal, and, generally speaking, it has been found that the coal crushed so as to pass through a screen of forty meshes to the inch gives, in our case, the best results.

This separation is, on the whole, superior for the finer coal, to the separation method by the Draper system, and gives less waste for a given percentage of ash.

The question as to which of the two systems, Draper or Flotation, should be adopted is a very difficult one, and has received most careful considerations. From the investigations made it has been found that the Draper system is more suitable for the grainier coal, and is not capable of treating the finer particles which form a considerable percentage of our coal. On the other hand, the Flotation system is only capable of treating the finer particles of coal, and consequently all the larger sizes would require to be crushed. There would be no serious objection to crushing were all the coal washed to be used for coke making at Chinwangtao, but as the larger proportion is for export abroad, the loss on handling and transport of such a fine material would be prohibitive.

Under these circumstances, we have decided to instal a washing plant utilising both methods for their special purposes. It is impossible to decide without further experiments, as to the proportion of coal to be washed by each process, and such experiments, if carried out in this country, would be very costly and would require a long time to

complete. It would be necessary to ship a large quantity of different grades of coal to be tested, and even these experiments would be nothing like so conclusive as if carried out in China with the machinery and coal on the spot. We have, therefore, decided to immediately order a small unit plant from both Drapers' and the Minerals Separation Company, large enough to make effective experiments under working conditions. With this smaller plant, which will afterwards form part of the definite scheme, experiments will be conducted and the extensions planned in accordance with them. After the installation of the small plant it will not be necessary to obtain any further plant from Europe, except possibly special pieces which it would be too difficult or costly to manufacture in our shops.

With this end in view, both the Rhondda Engineering and Mining Company (Draper system) and the Minerals Separation Company (Flotation system) have been dealt with and their terms obtained.

There is one other difficult subject to consider in connection with the washing plant, namely, the question of drying the washed coal.

We have experienced the greatest difficulty in our present plant, owing to the excessive moisture in the washed product, which has led to the railways refusing to carry it unless effectively dried ; their reasons for doing so are, that the moisture in the coal destroys the cars themselves, the somewhat acid water dripping from the coal, injuring the axle boxes and causing "hot boxes ;" the escaping water on the track causes rapid deterioration of the permanent way, and in winter time the freezing of the coal into a solid mass necessitates the breaking up of the mass by picks in the cars, to unload it, causing further damage to the cars. We have an enormous system of bunkers at the washing plant, solely necessitated by the urgency of drying the coal, but even this extensive reservoir capacity is insufficient, and it has become necessary to stock the washed product on the ground for several weeks before reloading into railway cars. It is true that by transferring the site of the washing plant to Chinwangtao, we do away with the haulage over the Chinese Government Railways, but at the same time all the difficulties now experienced, will be still experienced by ourselves although perhaps not to the same degree. It is obvious that if an effective system of drying can be utilized, a great expenditure in bunkers can be avoided, and our attention had been directed to this, even prior to the consideration of the present scheme. Various methods have been adopted from time to time in an endeavour to solve this problem, but the only probable effective ones are those by centrifugal force, or filtration by suction. The former process is carried out by a machine which whirls the coal round at great velocity, this causing the particles of moisture to separate from the coal, the water being led off the machine in one direction, and the dried coal is another. Two processes, the Wendel and the Elmore, both American, have been considered, and the question has been placed before the inventors of both. At the time of writing, no definite choice has been made, both processes appearing fairly equal in

efficiency and cost. Under these circumstances it has been decided to order a plant from America sufficient to deal with a part of the output of the small washing plant, the matter being placed in the hands of consulting engineers in America to decide which of the two systems will be most suitable for our conditions.

The second process is that known as the Oliver filter, which has been extensively used in the treatment of mineral slimes. The principle is that of a slowly revolving drum covered with a filtering cloth or canvas, in the interior of which a vacuum is created. The wet coal is poured on to the drum in an even thickness of two or three inches, as may be required, the revolution of the drum passing the coal over the vacuum, which sucks out the moisture through the filter covering and discharges the dry coal on to a conveyor. The principle will probably prove more effective for the finer coal, as it may be difficult to evenly distribute and hold the larger particles on the revolving drum. It is intended, after some further investigation, to order one of these filtering plants, and to erect it in conjunction with the centrifugal drier. It appears likely, in the end, that the Oliver system will be used for the fine coal washed by the Minerals Separation process, and the centrifugal system for the larger coal washed by the Draper process.

It is not anticipated that either of these plants will involve any considerable expenditure.

Since writing the above report there have been only slight alterations in the scheme outlined. The progress made has been in completing the design of the plant to make it more suitable for our purposes. Amongst other alterations has been the addition to the Draper system of a series of washing tubes to produce an intermediate grade of coal, so as not to pass too much of the washed material into the waste channels. The plant now ordered is capable of treating 1,450 tons per diem and producing 1,060 tons of washed coal. This is, of course, quite insufficient for our total requirements, which are as given above—5,200 tons per diem—which will be slightly increased owing to the coke ovens being capable of treating a larger amount of coal than was originally intended. This increase, however, is only intended as a safeguard against irregularities in working, and therefore need not be considered as affecting the original proposals for the washing plant.

Since writing my report of the 30th June agreements have been entered into with the Rhondda Engineering and Mining Company, Limited (Draper System) and Minerals Separation Limited, in which the main points are :—

The Draper System.—The price for the plant ordered, washing 40 to 50 tons per hour, was £12,500. This has subsequently been altered so as to provide for various additions to suit the circumstances, to £15,250. In addition, it is agreed that within two years of the supply of the plant, the Kailan Mining Administration, if they so

desire, shall pay to the Rhondda Engineering and Mining Company, Limited, a sum of £10,000, giving the Administration a general and exclusive Agency to introduce the process to other parties in China.

The Minerals Separation Process.—We purchase a plant capable of treating 200 to 250 tons per diem for a sum of £4,000. For twenty years we agree to pay to the Minerals Separation Limited three pence per ton on every ton of coal treated by their process. In addition, the Kailan Mining Administration becomes the agents of the Company to introduce their process in China, receiving ten per cent. of all royalties received by the Company for the use of their process in China.

The plant now ordered will only be capable of dealing with approximately 1,100 tons of washed coal daily. It is proposed with this plant to carry on experiments of a complete and exhaustive nature to determine the best possible combination of the two systems. The experiments so far conducted have conclusively proved the real value of the systems in washing our coal ; but it has not yet been definitely ascertained at what point of fineness in the coal it is desirable to change from the one system to the other. This can only be done after a period of experiment with the small plant under order. In subsequent additions it will be comparatively easy to regulate the final plant to take the maximum advantage of the combination.

It must be borne in mind that the necessity for the new washing plant is only in a small part due to the scheme for coke ovens and blast furnaces. The amount of coal to be washed for these purposes is 1,400 tons per diem, while the final washing plant will be capable of treating about 5,200 tons per diem, the larger proportion of the washed coal being required for the Japanese and Korean markets for coke-making purposes. The new plant is merely a replacement of the existing Baum plant at Linsi, and is in the main necessitated by the difficulty experienced in conveying our washed coal, with its considerable percentage of moisture, by rail. Under these circumstances I consider it desirable not to charge the whole plant to the capital scheme, as, were this done, it would be burdened with a charge which has nothing to do with it. A sound solution to this question can, I consider, be easily arrived at by debiting the new scheme with the original cost of the smaller plant now ordered, and to debit up all cost of extension to the reserve fund. The small plant will not be large enough to wash the coal required for the coke ovens, but, on the other hand, the works required for the small plant will provide to a considerable extent for the wants of the large plant to be subsequently installed.

The larger plant I propose to manufacture almost entirely in China, and to extend it gradually. During the period of extension, the deficiency in washed coals will be made up by the present Linsi plant, which will be worked on a decreasing scale till, by the time the Chinwangtao plant is completed, the Linsi plant will only be turning out the washed coal

necessary for local purposes, the requirements of which are practically entirely in the direction of Tientsin, and therefore must still be met from the plant at the mines.

I give below the estimate for the small plant now under order :—

1. Filling—150,000 fang at 40 cents ...	£12,000	6.000
2. Tracks—6 miles at $22,000 per mile ...	26,400	23.700
3. Draper plant (as per agreement) ...	15,250	15.250
4. Minerals separation plant (as per agreement)	4,000	4000
5. Material to be supplied in China for completing and combining the two processes	5,000	2.500
6. Dryers and accessories	10,000	10.000
7. Buildings and bunkers	15,000	7.500
8. Water supply, including wells, pumps, piping and water towers	10,000	5.000
9. Electrical equipment, motors, transformers, switchboards, etc.	8,000	8.000
10. Laboratory, office and store	5,000	2 500
11. Freight and duty on imported material	5,000	3 500
Total	£115,650	87. 950

I make the following remarks on the various items of this estimate :—

1. Filling.

The site of the washing plant, as shown on the plan, covers a considerable amount of low-lying ground which must be filled.

The item appears extravagant in comparison with the total cost of the plant; but it has been fully considered and the conclusion arrived at that the site selected is the only one really suitable. It will be remarked that the position chosen is at a considerable distance from the coke ovens, the reason being that nearly three-fourths of the coal treated will go direct to steamers for export, and the balance only to the ovens. The site for the washing plant must therefore be chosen from the point of view of facility for loading in steamers, and hence the decision arrived at.

The sum estimated for filling covers the whole of the filling required for the final plant. The greater part is due to the necessity of providing for raised ground for the railway approaches and sidings, in fact, a considerable area will be filled up which covers all the ground necessary for the big plant and accessories.

2. Tracks.

Here, again, the great length of approaches and sidings will suffice for the greater part of the needs of the final plant.

It must be remembered that in providing for the smaller plant, provision has to be made for the final lay-out, and consequently the tracks required in the future will only be of the nature of additional sidings to

deal with the increased traffic. The length of sidings now proposed is, therefore, to a large extent due to the main connections. This will be more evident when I give a résumé of the expenditure necessary to develop the plant to the full size anticipated.

3. Draper Plant.

This item covers the actual contract price agreed upon.

4. Minerals Separation Plant.

The same as for Item 3.

5. Material to be supplied in China for completing and combining the two Processes.

This amount can only be vaguely estimated, and the detail cannot be fixed until the experimental interval has passed. The sum allowed should be amply sufficient to cover all charges.

6. Dryers and Accessories.

Delays have occurred in obtaining the data necessary for full consideration of this item.

The estimated expenditure under this head is based on the known cost of the various machines under consideration, and the cost will probably be considerably below the estimated amount.

7. Buildings and Bunkers.

The cost of these has been estimated from the actual design of the buildings already prepared.

8. Water Supply.

The provision made under this head should be ample. It is a little difficult, however, to give an estimate of the cost, owing to the fact that the site of the water supply, and therefore the length of connections, has not been definitely determined.

9. Electrical Equipment.

The cost of these supplies has been estimated from known data, the power required to be developed being known within a small margin.

10. Laboratory, Office and Store.

This item calls for no special remarks.

11. Freight and Duty.

This item also calls for no special remarks.

I give below an estimate of the cost of completing the final plant, although, for reasons already stated, the amount required need not be considered for the purposes of these estimates :—

Additional tracks	£18,000
Material (of which a small proportion only will be imported)	70,000
Additional buildings and bunkers ...	30,000
„ dryers	20,000
„ water supply	10,000
„ electrical equipment	10,000
Purchase of the Draper rights	10,000
Accessories and spares	10,000
Total	£178,000

It will be seen therefore that the expenditure for the additional plant to be added gradually to increase the washing capacity from about 1,400 tons to 5,200 tons, amounts to £178,000, as compared with the original cost of ~~£115,650~~ 87.950 for the 1,400 tons plant.

3.—COKE OVENS.

In my report of the 30th June, I wrote as follows :—

The question of the actual design of the coking plant does not present so much difficulty as that of the washing plant, particularly as our coal is of a very good coking quality, and the coking practice is one which has received most careful attention in Europe and America during the past few years.

It has therefore only been necessary to consider the question as to which form of plant would be most suitable for the conditions of our work in China. The matter has been carefully studied both in Europe and America and estimates have been called for from England, Belgium and America.

The practice in America and Europe differs considerably.

The Americans have endeavoured to reduce the coking time and thus increase the output from a given number of ovens. They do this by lining the ovens with a strongly heat-resisting brick, by which means they are able to rapidly cokify the coal while preserving the walls of the ovens.

In Europe, on the other hand, the conditions have been such that it has been considered advisable to use an aluminous silica brick which necessitates slower carbonization of the charge.

We have listened carefully to the arguments brought forward by the best authorities on both sides, and have come to the conclusion that in our case it will be preferable to adopt the European practice. It would be impossible in this report to go through the arguments for and against the rival processes, as the question is an extremely debatable one and

there are many factors to consider, some to the advantage of one system and some to the other.

Two of the principal considerations which have led us to consider the European system as the better for our purpose are, firstly, that it will be easier for us to manufacture an aluminous silica brick than a reliable silica brick, in China, and if we can avoid importing any bricks, the capital cost of the plant would be much reduced; secondly, that the silica brick deteriorates rapidly when moist coal is carbonized, as in our case.

It must be remembered that in all cases, except perhaps the Roberts ovens, the various systems of cokification can be adapted for the use of either silica or aluminous silica bricks.

After careful consideration and investigation of many modern plants, the conclusion we have come to is that it will be desirable to select the type of oven to be used rather from the financial than from the technical point of view. Under the circumstances we have made a careful selection of firms which may be said to comprise the best known authorities on coke-oven practice, and have asked them to submit tenders for the whole plant, including the by-product recovery plant. The firms selected are as follows :—

Messrs. Freyn and Brassert, Consulting Engineers, Chicago; American.

Mr. Wilputte, New York; American.
The Foundation Company, New York; American.
Société Franco Belge de fours à Coke, Brussels; Belgian.
Koppers Company, England; British and American.
Evence Coppee and Co., England; British and Belgian.
Simon Carves, Ltd., England (Manchester); British.

Messrs. Freyn and Brassert were asked to quote with a view to obtaining figures with regard to the Roberts ovens. Unfortunately, they have not understood the request sent them and have informed us that, not being specialists in coke oven plants, they do not propose to quote. This eliminates the Roberts oven from the tenders to be received. We have, however, carefully considered the question of the use of this oven, and while recognising the possibility of a considerable advantage from it, we have come to the conclusion that the practical result so far achieved has not been sufficient to warrant its adoption. The advantage claimed for the oven is that the constructional design enables a better regulation and more even heating of the oven, and consequently greater production and uniformity of by-products. This, in our case, would undoubtedly be of considerable benefit, but, on the other hand, it is impossible to obtain absolute proof of the results on a satisfactory scale, and the risk involved in constructing ovens of a new type in China is too great to allow of our adopting the principle.

Mr. Wilputte is the designer of an oven which is based on the same principle as the Koppers oven, but with some modifications. The oven

has been installed in several places, and was selected by the Chief Engineer of the Mitsubishi Company for their new works at Kenjiho, Korea, after a very exhaustive study by him. Mr. Wilputte is prevented from supplying plant in America, as the Koppers Company successfully pursued an action in the American Courts for infringement of patents.

The remaining firms are all well known and established, and each has its type of oven, which differ slightly from each other, but the results of which are very similar.

In calling for estimates, a memorandum has been addressed to each firm (copy attached) giving the basis on which they should be made. A wide latitude has been given so as to enable each firm to include all the particular details which they generally apply. It will be necessary to considerably alter the proposals submitted in order to obtain the most suitable arrangements to meet our case. Many details, such as quenching in a central station, or on the bench, methods of loading furnaces, etc., have been considered, which it is not necessary to enter into here, and on which it is not desirable to come to a decision until a tender has been accepted and such details have been thoroughly discussed with the contractors.

Estimates are expected very shortly from all those asked to quote, and when these have been received it will take a comparatively short time to work out the final scheme.

Since the above was written, the tenders called for have been received.

After careful consideration it was decided to call in the advice of a well-known operator and technical expert with very great experience, to advise on the plant he considered best for our purposes, having regard to its technical value combined with the capital cost. Out of the tenders received he selected two, both approximately the same in price, and which he considered entirely suitable for our purposes.

The advice given corresponded with the ideas I had already formed as to the value of the different systems and the desirability of adopting them.

Both firms tendering were, before finally deciding, given an opportunity of amending their estimates, and the final prices quoted gave a preference to the project submitted by the Société Franco Belge de fours à Coke, Brussels.

The price asked at the time of submitting the tender was £375,000, but this estimate covered material at a time when the value was considerably higher than at present, and as the contract will stipulate that we obtain the benefit, less a small percentage, of any lowering of prices in general, it may be assumed that at current rates a considerable saving will be effected.

I estimate that, omitting for the moment the items common to other portions of the scheme, the actual cost of the coke ovens and accessories will be as follows :—

1. Cost of plant (including Contractors' fee)	~~£375,000~~	327.500
2. Salaries (10 skilled erectors for two years)	~~20,000~~	10.000
3. Freight and duty	~~35,000~~	29.500
4. Office	~~1,000~~	500
5. Rest room for Chinese	~~2,000~~	1.000
6. Refractories (all made in our brick-works)	~~45,000~~	22.500
7. Stores	~~1,000~~	500
8. Foundations (extra to those estimated in contract)	~~20,000~~	10.000
9. Spares	~~15,000~~	15.000
10. Special tracks	~~7,000~~	7.000
Total	~~£521,000~~	423.500

It will be noted from the above that it is considered that all the fire-clay bricks and material, are estimated for to be made in China.

Up to the time of writing this report the results of the full experiments with our materials, now being carried out, have not been received, and therefore I am not able to give a definite assurance that some part of the material will not have to be imported. On the other hand, such definite opinions have been expressed by Dr. Mellor and the experts of the Société Franco Belge de fours à Coke, that I have little hesitation in the present estimate of allowing for all requirements being made by ourselves in China. With this in view, I have provided for additional plant later on for our brickworks to enable them to cope with the new work entailed.

It will be noted that an amount of ~~£20,000~~ £10.000 is allowed for foundations. These are provided for in the general estimate of the plant, but it has been considered desirable to allow for further work that may perhaps be found necessary after further tests, now being carried out on the site of the works, are completed. So far, the site has been tested with a weight of four tons to the square foot and found well capable of supporting this, whereas no part of the plant will bring a weight of more than two tons to the square foot to bear on the ground. The provision in the estimates, therefore, covers such further work as may be necessary when the results of the tests now proceeding are known.

The estimate of £375,000 submitted by the Société Franco Belge de fours à Coke includes a by-product plant amply sufficient to treat all the gas produced by the daily carbonization of 1,400 tons of washed coal.

4.—BY-PRODUCT RECOVERY PLANT.

In my report of the 30th June, 1920, I made the following remarks :—

It has been decided so far to include the production of the following materials from the coke-oven gas :—

Sulphate of ammonia.
Coal tar and its products, as required.
Benzol.

The further development of the products will require much study and this will be carried out in China during the course of the next few years. A ready market is certain for the three products now provided for.

The Shell Transport officially permit me to state that they are prepared to purchase all the benzol we can produce, so that there is no doubt of a considerable profit from this source alone.

The value of sulphate of ammonia has considerably increased since my original scheme for the treatment of our coal was initiated, and the market in Japan has also considerably increased.

The consumption of tar and tar products is also largely on the increase in the Far East.

The by-product plant is, therefore, certain to be a very paying part of the installation.

The mechanical details of the plant will only be settled when the tenders for the coke-oven plant are received, as they, as is usual in such cases, form part of the details to be submitted by those firms who are to furnish the tenders. Generally speaking, there is no very great difference in the plants usually erected. Some firms employ somewhat different processes with regard to tar distillation and the rectification of sulphate of ammonia, but these are matters of minor importance and will be settled later with the firm successful in obtaining the contract for the coking plant.

The recovery plant provides for the condensation of the tar which will be collected and either pumped to storage tanks for direct sale or to a complete tar distillation plant to dehydrate the tars, distil them, to obtain the crystallization of naphthalene, its drying, and the storage of oils and pitch. The products obtained from this plant, therefore, besides a certain quantity of tar, for sale, will be light oils, mean oils, anthracenic oils, naphthalene and pitch.

The estimate provides for extracting the ammonia in the gas and its conversion in closed saturators into crystallised sulphate of ammonia. The sulphuric acid necessary for this will be manufactured at a separate plant, estimated for later on in this project.

The by-product plant also includes a plant for washing, purifying and rectifying benzols, designed for treating the gas produced by a daily carbonization of 1,400 tons washed coal, and includes the washing of

naphthalene, the cooling of the gases leaving the saturators, the recovery of benzols with oil, the purification of the crude benzols with acid, soda and water, and their rectification, after purification, in order to produce the commercial products 90 per cent. and 50 per cent. benzol, toluol and Dyer's naphtha.

5.—SULPHURIC ACID AND NITRIC ACID PLANT.

In my report of the 30th June, 1920, I made the following observations :—

The question as to the supply of raw material for the manufacture of sulphuric acid has not yet been settled. Instructions have been given in China to make a thorough investigation of all sources of supply. There are two kinds of material that may be utilized, namely, raw sulphur or pyrites. These are both available in considerable quantities in both China and Japan and it is only necessary to find the cheapest source. I expect to shortly be able to determine this.

There are two processes generally used for the manufacture of sulphuric acid—the chamber and the contact. The latter is used for turning out a highly concentrated acid, and the former for a less concentrated acid. As the larger part of our output—25 tons out of 30 tons per diem—will be used for the manufacture of sulphate of ammonia, which does not require a highly concentrated acid, it has been decided to adopt the chamber process. A small supply of highly concentrated acid will be required for the purification of benzol, and it will therefore be necessary to instal a small concentrating plant for this purpose; this will not, however, be at all costly. The balance of the sulphuric acid turned out will be sold on the market, and give very good profits. A very rough estimate for the plant, furnished by Messrs. Simon Carves, gives the cost at £60,000, but as this includes all the necessary brickwork, which will probably be manufactured in China, the cost of the material in Europe should be considerably less. Estimates for this plant will be included in the estimates already called for from the coke oven manufacturers, and the purchase of the plant will follow with that of the coke oven plant.

Since writing the foregoing note on the establishment of a Sulphuric Acid Factory I have been informed by Sir Robert Waley Cohen of the Shell Transport, that his firm would be willing to take a large quantity of concentrated sulphuric acid from our factory. This may, to some extent, modify our original installation, and it is possible that fresh proposals may have to be made later.

Some little difficulty has been found with regard to estimating for this plant, as up to the time of writing it has not been definitely decided as to what source should be gone to for the supply of the sulphur. It will probably be found that the supply will come from Japan, where

copper pyrites could be purchased, brought to Chinwangtao by our coal boats now returning empty at a cheap rate of freight, treated, and the residual copper sold at a remunerative rate. The estimate submitted by the Société Franco Belge de fours à Coke is based on the treatment of pyrites.

The total cost of this plant is estimated as follows :—

1. Cost of plant	~~£43,000~~	35.000
2. Freight and duty	~~4,000~~	3.500
3. Foundations	~~3,000~~	1.500
4. Fee	~~6,000~~	6.000
5. Salaries (4 skilled erectors for 1 year) ...	~~4,000~~	2.000
6. Electrical equipment	~~1,000~~	1.000
7. Stores and sulphuric acid	~~4,000~~	2.000
Total	~~£65,000~~	51.000

6.—BLAST FURNACES.

In my report of the 30th June, 1920, I made the following remarks :—

The original idea was to instal one 250-ton Blast Furnace, with accessories.

The question of the capacity of the Plant has been discussed with experts in America and Europe, and as a result we have decided that the erection of two 250-ton furnaces, capable of subsequent enlargement to produce approximately 350 tons per diem, will be most suitable.

The American modern practice is, generally speaking, to erect furnaces of greater capacity, from 500 to 600 tons per diem, and the question as to whether or not we should follow this practice has had to be carefully studied. The practice in Europe has not followed the American, although it is a much debated question here. We have been led to adopt the principle of smaller furnaces, for the following main reasons :—Firstly, because a small furnace is easier to operate in a distant country with labour not trained to the high pitch attained by operators in the United States, thus minimising the danger of failures and of damage to the furnace ; secondly, the output is more easily regulated and the quality of the pig iron produced is likely to be better. This latter reason is of great importance as, for the near future, it is desired to produce as good a quality of Foundry Pig as possible, and although subsequently it is likely that we shall produce steel which perhaps might be equally well produced with a large as with a small furnace, it is better not to sacrifice the quality of the immediate output for future possible requirements.

In making the furnaces capable of a greater output in the future, sufficient provision is made for an early start in the steel business, if required. Only a small extra expense is involved in this provision, the main difference being that a somewhat larger shell is provided, and the thickness of the firebrick lining increased. When it is desired to

increase the capacity of the furnace, the lining will be removed and the thinner lining substituted. This would naturally take place at a time when, owing to ordinary wear and tear, the lining would have to be replaced.

The reasons which have led to the adoption of two furnaces instead of one are mainly economical, but are also due to the extra safeguard to a continuous output being maintained. It is far easier to regulate the output with two furnaces instead of one, and if anything goes wrong with one furnace, or it is necessary to close down for repairs, the second furnace will continue to form a source of supply.

There is every prospect of an enormous demand on our production as soon as it commences, and it will probably be desirable to make long contracts ahead in order to obtain the best advantage of high prices at any given moment.

Under these conditions, the better security there is for an uninterrupted output the greater will be the facility in disposing of the material turned out.

It is to be regretted that, at the time of writing, no estimates of costs of the plant are available on which to base an idea of the economical advantage of erecting two furnaces instead of one. These calculations will have to be discussed in a future report, but it seems that, even without them, the advantages of the proposals are evident. The profits immediately accruing from the output, assuming all the latter to be readily saleable, of which there is no doubt, will be in hand twice as fast with two furnaces instead of one, and it is obvious that such profits, after deducting a higher rate of depreciation, will be far more valuable if accruing in 15 years instead of 30. This is all the more the case as the proportion of profits to capital cost will be extremely high.

The question of the type of furnace to be adopted, with the necessary plant, has been definitely decided, and drawings and estimates on the basis of those decisions are now in course of preparation by Mr. Roberts. As soon as the designs have been received, estimates will be called for and the contracts let. It is not anticipated that any great delay will be involved, and consequently it is hoped that the orders for material can be placed in the near future. Tenders will be called for in Great Britain, Belgium and America, and will be fully considered before the work is let out.

It is unnecessary to go into the question of the details of the work here. The designs adopted will, to a certain extent, differ from the most modern practice, which call for labour saving devices in all details. Provision will have to be made in the lay-out giving space for the addition of such labour saving appliances—should the circumstances demand their adoption—but, for the present, all expenditure which is not absolutely necessary in this direction will be avoided. For instance, it is proposed to discharge all the ore and coke on to the ground, to load this material into tubs, which will be hand-hauled

to an elevator, raised to the level of the top of the furnace and again hand-hauled and discharged at and into the furnace. Such a system would not appeal to the modern furnace builder, who would adopt machine hauling by skips or buckets, and revolving tops to the furnaces for mechanical loading ; in our case, however, labour costs being so small, the capital expenditure involved would not be compensated by the saving effected. Added to this, the system of hand loading has advantages which some experts consider of great importance.

Since the above was written considerable delay has occurred in the preparation of the designs and specifications for the blast furnaces, which were only circulated to the contractors on the 1st November.

I do not anticipate receiving any tenders for the works for several weeks, and therefore, in order not to delay this report, I have had to rely for the estimate of cost on figures supplied by Messrs. Harbord and Roberts. As these estimates are based on a price of material considerably higher than at the moment of writing, I believe that the estimates will be very much on the safe side.

Since writing my report of the 30th June, an important alteration has been made in the designs, namely, the substitution of mechanical for hand charging of the furnaces. I have been a strong advocate for hand charging, believing that it would be possible to train Chinese labour to a degree that would make the hand labour practically as automatic as the machinery. In order to convince myself of this I instructed Mr. McConaghy, who has had for many years past the handling of all our labour at Chinwangtao, to proceed to Wales to personally observe the conditions under which the work would be done on the top of a blast furnace. He remained for a considerable time on a very bad day watching the charging of a furnace, and as a result reported that it would be unsafe to rely on Chinese hand labour to give absolute security against irregular loading. Under these circumstances I have decided that while providing for hand labour at the ground level, it is desirable to allow for mechanical charging at the top of the furnaces. The design adopted in the present estimates is the bucket system, which is considered by experts to be better than the skip system. The extra expenditure involved is considerable, but I do not consider it advisable to take any risks in the matter, after the expert advice I have received.

The estimate furnished to me as to the probable cost of the furnaces, with accessories, is as follows :—

	£	
1. Ore stock gantry, including bunkers ...	~~55,000~~	27.500
2. Steelwork for blast furnace stoves, dust catchers, Mechanical charging and chimneys	~~305,000~~	252.500
Carried forward ...	~~£360,000~~	280.000

	£	
Brought forward ...	~~360,000~~	280.000
3. Brick lining for furnaces and stoves, including labour. (Bricks for stoves and backing made in China) ...	~~90,000~~	48.500
4. Dry dust cleaner	~~30,000~~	30.000
5. Blowing engines, condensers, cooling tower, boilers and chimney ...	~~155,000~~	140.000
6. Foundations	~~50,000~~	25.000
7. Office	~~1,000~~	500
8. Stores	~~1,000~~	500
9. Metal ladles	~~11,000~~	11.000
10. Slag ladles	~~16,000~~	16.000
11. Tools and spares	~~20,000~~	20.000
12. European skilled assistance	~~7,000~~	3.500
13. Trucks for ore and limestone	~~20,000~~	20.000
14. Ore and crushing plant	~~40,000~~	25.000
15 Freight	~~58,500~~	58.500
16. Duty	~~22,000~~	11.000
17. Water tower	~~15,000~~	7500
18. Buildings	~~35,000~~	17.500
Total	~~£931,500~~	714.500

It will be noted that the estimate provides for the Hearth and Bosh bricks being imported from Europe. I have allowed for this at the express desire of Mr. Harbord, but I think that on further experience we shall find we are well able to manufacture them in China. As regards the bricks for stoves and backing, we are perfectly satisfied, our bricks having already been exclusively used and subject to lengthy trial in the Hanyang Iron and Steel Works, who now purchase all their bricks from us. Our Hearth and Bosh bricks have been installed in the Yangtsze Engineering Works, which were started up in April last, and we shall shortly be able to judge from the results obtained in these furnaces whether it is safe to rely on them. The reports of the Engineer of these works (a representative of Messrs. Perin Marshall & Company, of New York), have so far been very favourable. It may be noted that since the supply of these bricks, considerable improvement has been made in the manufacture as a result of the experience already gained.

It will be noticed that a sum of £50,000 has been allowed for foundations. As already mentioned, in considering the question of foundations for the coke ovens, the expenditure necessary for this item has been based on data at present not definitely fixed. I hope that when conditions have been better studied, it may be found possible to considerably reduce the expenditure under this head.

The remaining items of the estimate do not call for special remarks.

7.—ALTERATIONS AND ADDITIONS TO BRICK-MAKING PLANT.

I attach hereto a report and estimate prepared by Messrs. Sutton & Nardy (our brick expert), on the expenditure necessary to develop the existing brick factory to meet the Mines' and Market requirements, and also to provide for the erection of a plant to furnish the necessary bricks for the new coke ovens and blast furnace plant.

The amount required for the Mines and Sales requirements must be met out of the Reserve Fund, and it will only remain to deal in this report with the requirements of the new plant, amounting in round figures to £140,000.

This sum includes a plant for the manufacture of tiles of the Marseilles pattern.

It has been decided that the cost of roofing the large area of buildings to be erected in connection with the new plant will be more economically met by putting up a tile making plant, than employing corrugated iron, no suitable local material being available.

It must be remembered that all the plant now being debited to the coke ovens and blast furnaces will, in the future, provide a source for revenue earning.

It is probable that the manufacture of siliceous bricks will, in view of the industrial expansion in China, provide for wants of which we shall be the only practicable suppliers. The plant will also, to a large extent, provide for the growing requirements of the firebrick trade.

In this estimate, however, the future earnings from the money expended have not been considered in the calculations, the prospective benefits not being sufficiently definite to allow of any reliable estimate.

The following table gives the detail of the estimates considered above :—

ESTIMATES FOR NEW PLANT AT CHINWANGTAO.

General Works.

		£
1	Preparation of Site	~~21,000~~
2	General Offices ...	8.000 ~~10,000~~
3	Laboratory ...	2.000 ~~4,000~~
4	Bungalows and Coolie Lines ...	13.500 ~~17,000~~
5	Workshops ...	5.000 ~~10,000~~
6	Roads	2.000 ~~4,000~~
7	Lighting	7.500 ~~10,000~~
8	Stores	3.000 ~~6,000~~
9	Railway from Subway to Hills near Tang Ho	102.865 ~~130,000~~
10	36 Thirty-ton Cars	52.000 ~~74,000~~
11	4 Locomotives ...	42.000 ~~44,000~~
12	Railways from Junction to various Plants	55.000 ~~65,000~~
13	Ten-ton Locomotive Crane	~~12,000~~
14	Main Transmission Lines	5.000 ~~10,000~~
15	Stone Crusher and Mortar Mills	5.625 ~~6,000~~
16	Water Supply ...	36.250 ~~52,500~~
17	Power Plant ...	170.350 ~~180,000~~
	TOTAL	£519,090 ~~£624,500~~

Washing Plant.

		£
1	Filling	6.000 ~~12,000~~
2	Railway Tracks ...	23.700 ~~26,000~~
3	Draper Plant ...	15.250 ~~15,250~~
4	Minerals Separation Plant	~~4,000~~
5	Mineral Dry Plant	2.500 ~~5,000~~
6	Dryers and Accessories ...	~~10,000~~
7	Buildings and Bunkers	7.500 ~~15,000~~
8	Water Supply ...	5.000 ~~10,000~~
9	Electrical Equipment ...	8,000
10	Laboratory, Office and Store	2.500 ~~5,000~~
11	Freight and Duty	3.500 ~~5,000~~
	TOTAL ...	~~£115,650~~ 87.950
	Add: Proportion of General Works Expenditure ...	~~20,000~~ 18,900
		£ 106,850
	TOTAL ...	~~£135,650~~

Coke Ovens: (With bye-product Recovery Plant).

		£
1	Cost of Plant ...	375,000
2	Salaries	20,000
3	Freight and Duty	35,000
4	Offices	500 1,000
5	Rest Room for Chinese	1.000 2,000
6	Refractories ...	22.500 45,000
7	Stores	1.500 1,000
8	Foundations ...	10.000 20,000
9	Spares	15,000
10	Special Trucks	7,000
	TOTAL ...	£521,000 423,500
	Add: Proportion of General Works Expenditure ...	202,550 246,250
		£767,250 626,050
	Add: Proportion of Brick-works Plant	70,000 55,000
		681,050
	TOTAL ...	£837,250

Sulphuric Acid Plant.

		£
1	Cost of Plant	35.000 ~~43,000~~
2	Freight and Duty	2.500 ~~4,000~~
3	Foundations	1.500 ~~3,000~~
4	Contractors' Fee ...	~~6,000~~
5	Salaries ...	2.000 ~~4,000~~
6	Electrical Equipment	1.000
7	Stores and Sulphuric Acid ...	2.000 ~~4,000~~
	TOTAL ...	£ ~~65,000~~ 51.000

Blast Furnaces.

		£
1	Ore Stock Gantry and Bunkers	~~55,000~~
2	Steelworks for Furnaces, Stoves, etc.	285.500 305,000
3	Refractories	48.500 ~~90,000~~
4	Dry Dust Cleaner ...	30,000
5	Blowing Engines	140.000 ~~165,000~~
6	Foundations ...	15.000 ~~30,000~~
7	Office	500 ~~1,000~~
8	Stores	500 ~~1,000~~
9	Metal Ladles	11,000
10	Slag Ladles	16,000
11	Tools and Spares ...	20,000
12	Salaries	3.500 ~~7,000~~
13	Trucks for Ore and Lime-stone	20,000
14	Ore Crushing Plant	25.000 ~~45,000~~
15	Freight	58,500
16	Duty	11.000 ~~22,000~~
17	Water Tower ...	7.500 ~~15,000~~
18	Buildings ...	17.500 ~~35,000~~
	TOTAL	~~£931,500~~ 714,500
	Add.—Proportion of General Works Expenditure	202,550 ~~246,250~~ 917,050
	TOTAL ...	£ ~~1,177,750~~
	Add:—Proportion of Brick-work Plant	~~70,000~~
	TOTAL ...	£ ~~1,247,750~~

Brickworks.

	£
Additions to Brick works	~~110,000~~ 110,500

Item. General Works Expenditure.

Item.	Washing Plant.	Coke Ovens.	Blast Furnaces.	Chinwangtao development.
	£	£	£	£
1	—	5,000 ~~10,000~~	~~10,000~~ 5000	—
2	—	2,500 ~~5,000~~	~~5,000~~ 2500	—
3	—	1,000 ~~2,000~~	~~2,000~~ 1000	—
4		6,500 ~~13,000~~	~~13,500~~ 6500	
5		2,500 ~~5,000~~	~~5,000~~	
6		1,000 ~~2,000~~	~~2,000~~	
7		3,000 ~~6,000~~	~~6,000~~	
8		1,500 ~~3,000~~	~~3,000~~	
9	—	23,725 ~~30,000~~	~~30,000~~ 23725	~~70,000~~
10	—	26,000 ~~27,000~~	~~27,000~~ 26000	—
11	—	21,000 ~~22,000~~	~~22,000~~ 21000	—
12	—	27,500 ~~32,500~~	~~32,500~~ 27500	—
13	—	6,000	6,000	—
14		~~5,000~~	~~5,000~~ 2500	
15		~~2,000~~	~~2,000~~ 1000	2,000
16		~~10,000~~	~~10,000~~ 2500	
17		~~60,000~~	~~60,000~~ 56425	40,000
		~~£246,250~~	~~£246,250~~ 20425	~~£112,000~~

Total.

		£
General Works	519,090	~~624,500~~
Washing Plant	87,950	~~115,650~~
Coke Ovens	423,500	~~721,000~~
Sulphuric Acid Plant ...	51,000	~~65,000~~
Blast Furnaces	714,500	~~931,500~~
Brickworks	110,000	~~140,000~~
TOTAL ...	1,906,040	~~£2,997,650~~
Deduct Expenditure debitable to Chinwangtao Development...	95,090	~~112,000~~
TOTAL ...	1,810,950	~~£2,285,650~~

Allocated Expenditure on New Works.

		£
Washing Plant	126.850	~~135,650~~
Coke Ovens	681.050	~~837,250~~
Sulphuric Acid Plant ...	51.000	~~65,000~~
Blast Furnaces	972.050	~~1,247,750~~
TOTAL ...	1,810,950	~~£2,285,650~~
Add:— Engineers' Fees and Contingencies ...		187,175 ~~214,350~~
TOTAL ...	£ 1,998,125	£2,500,000

COST OF PRODUCTION OF VARIOUS PRODUCTS.

Washed Coal.—The cost per ton of unwashed coal at the washing plant will be as follows :—

Cost of coal at pit's mouth	$1.60 per ton.	1,90
Rail freight	$0.65 ,,	0,65
Handling charges	$0.15 ,,	0,15
Total	$2.40 ,,	2,70

Approximately 1.25 tons of unwashed coal are required to produce 1 ton of washed coal. Therefore, the cost of the coal will be $3.00, to which must be added the cost of washing, estimated at 50 cents., including all charges for depreciation, maintenance of plant, labour, etc.

The cost of one ton of washed coal sent to the coke ovens will therefore amount to $3.50.

Coke.—By the modern by-product recovery plant it is estimated that 1·4 tons of washed coal will be required per ton of coke produced. The cost of the coal used for the production of one ton of coke will therefore be $4.90.

The cost of labour, depreciation and maintenance of plant, including the by-product plant, is estimated at $2.00 per ton of coke produced, and therefore the total cost of one ton of coke will be $6.90.

It will be interesting to compare here this estimate with what would be the actual cost of the production of coke at Chinwangtao by the Chinese Beehive Ovens now used at the mines.

For this purpose it would be necessary to use 1·85 tons of washed coal per ton of coke produced. The coal costing $6.48, and adding 50 cents per ton for labour, etc., the cost of 1 ton of coke would be $6.98.

It will thus be seen that, notwithstanding the very heavy charges for depreciation and maintenance of plant, the actual cost of coke by the modern method, in consequence of the great saving of coal, is slightly lower than that of the primitive method in use.

This estimate does not take account of the valuable by-products produced by the new method and not by the old one.

Sulphuric Acid.—It is difficult to estimate at the present moment the actual cost of the production of sulphuric acid, as I have not definitely decided upon the source from which the material required is to be obtained. It is probable that the sulphur necessary will be provided by the treatment of copper pyrites purchased in Japan, the copper residue being sold. This arrangement would reduce the cost of the sulphuric acid materially. In my former estimate I valued such pyrites at $10.00 per ton, delivered at Chinwangtao. I propose to take a figure of $20 per ton without allowing for the re-sale of the copper.

One ton of pyrites of the description available will serve for the production of 1.80 tons of sulphuric acid, which will therefore cost say

$12.00 per ton. Adding other material required, $5 per ton, cost of labour $5 per ton, depreciation $4 per ton, and maintenance—which is likely to be a heavy charge—$5 per ton, the total cost of sulphuric acid will work out at $31 per ton. The current price of Sulphuric Acid in China may be taken at $80 per ton, so that the surplus production should be readily saleable at a considerable profit.

This, however, will be only a small item of the profit earning capacity of the Plant and will not be further considered.

Sulphate of Ammonia.—The yield of Sulphate of Ammonia per ton of coke produced has been variously estimated by different authorities. I consider that it may be looked upon as practically certain that we shall obtain 1 per cent. of the coal treated, which works out at ·014 tons per ton of coke manufactured.

For every ton of Sulphate of Ammonia produced one ton of Sulphuric Acid will be used, and the cost being $31 per ton, this will represent the actual cost of the Sulphate of Ammonia, allowance having already been made for the cost of labour, depreciation, etc., of the by-product plant in the cost of coke.

Benzol.—The production of Benzol will be ·0084 tons per ton of coke produced.

It is not necessary to charge up the production with any costs for labour and depreciation, as these have already been estimated for in the coking costs.

Coal Tar.—The cost of production of Coal Tar has also been already included in the estimates and may be considered as nil. The yield of Tar may be taken to be ·056 per ton of coke produced.

In the estimate for the By-Product Plant provision has been made for a Tar Distillation Plant, which will produce other materials than those enumerated above, and which will be of much greater value than the tar itself. For the purpose of this estimate, however, I propose to ignore these details, which will go to increase the factor of safety in considering the financial results generally. I also propose to ignore the profits which in future will be derivable from the sale of waste gases, either as such or utilized for the production and sale of power. It must also be remembered that the power plant which will utilize the coke oven gas will practically replace all the expenditure now incurred on the production of power for the general service of the port of Chinwangtao.

Iron.—The cost of producing pig iron is very difficult to estimate, owing to the fact that there is very little experience in China on which to base an estimate.

In M. Docquier's original calculations it was considered that $10.70 would be sufficient to cover all charges. When this estimate was submitted to Mr. Harbord, the latter, working on M. Docquier's figures and altering them to provide for all items which from experience he considered necessary, the cost was put down at $17.90. Mr. Harbord's want of

knowledge as to working in China was partly responsible for the increase, the balance being due to his intimate knowledge of actual costs in England.

I have considered the matter very fully and have taken working costs in England at the present time and tried to apply these costs to conditions in China.

The pre-war working costs in England, at an average installation, amounted to 7s./4·35d. At the present time it may be considered that these costs are approximately doubled, and will amount to say fifteen shillings. Taking item by item of charges included in these estimates and adapting them to Chinese conditions, I have come to the conclusion that an allowance of $5.00 per ton for labour and material, including cost of relining stoves at 5-year intervals, is sufficient. This estimate is prepared on a detailed examination of all costs of labour, including European supervision, which it will be possible to gradually eliminate. Depreciation, calculated to cover the original cost of plant in 15 years, is estimated at $2.75 per ton, and maintenance at $1.00 per ton. The cost of ore per ton of pig produced, including transportation charge, is estimated at $4.80. The cost of coke is taken at $1.20 per ton of pig produced. It is estimated that the limestone required will cost $1.50 per ton, or $0.75 per ton of pig produced.

The estimate of cost works out therefore as follows :—

Labour and material, including relining ...	$5.00
Depreciation	2.75
Maintenance	1.00
Ore	4.80
Coke	1.20
Limestone	0.75
TOTAL—Per ton of pig produced	$15.50

ESTIMATE OF PROFITS.

Washed Coal.—I do not propose to include any sum in these estimates on account of profits on washed coal. I consider it is best to treat the plant as a replacement of the existing plant, added to to furnish sufficient output for our coke kilns.

The price of the coal to the kilns will be considered at actual cost, and that for the coal sold outside will be considered as part of the ordinary sales of the coal branch of our business.

Certain advantages will accrue from the plant, such as more complete washing, and consequently improved products, and better sales price, but I propose to ignore these.

Coke and By-Products Recovered.—It will be advisable to consider the profits from the coke and by-products collectively.

In order to simplify the consideration of the subject in the estimate I give below, I calculate the profits on each item and then credit these profits to the coke account, making the sums received on the by-products go to reduce the cost of coke produced.

No account will be taken of the probable profits on the sulphuric acid factory, as the quantity available for sale over and above what is required for the manufacture of sulphate of ammonia, is small.

Sulphate of Ammonia.—The cost of the production of sulphate of ammonia will be $31 per ton. The total production will be 14 tons a day, or 5,000 tons per annum. The present export price in England is £35 per ton, which will give the cost delivered in China or Japan, approximately £42 per ton, or ~~$210.~~ 420 The prices in China and Japan where the production is quite insufficient to meet the demand, may be taken as ruled by the European prices. There is no doubt that the present price is inflated, and, that at times, at all events, the price will be lower than at present.

For the purposes of this estimate, I will consider the price obtainable in China, at $150 per ton, which, with cost of production at Chinwangtao, at $31 per ton, packing charges $3 per ton, handling $0·30 per ton, and export duty $6 per ton, giving a total cost f.o.b. of $40·30, will give a profit of, say, $100 per ton, or, for 5,000 tons a year, of $545,000, which, at the present rate of exchange, makes approximately ~~£109,000.~~ £ 54,500

Benzol.—The production of benzol will be ·0084 tons per ton of coke produced, or a total of say, 3,000 tons per annum.

The present price of benzol for export in England is £35 per ton, and therefore, in China, allowing £7 for freight and expenses, the price would be £42 per ton, equivalent to ~~$210.~~ 420 Assuming a sale price of only $150 per ton, the profits derived from the sale of benzol will amount to $450,000, or approximately ~~£90,000~~ £ 45,000 per annum.

Coal Tar.—The production of coal tar will be ·056 tons per ton of coke produced.

The cost of coal tar in China is at present about $50 per ton, and the export price in England is £7 per ton.

The total production of coal tar per annum will be approximately 20,000 tons, and the profit therefore will amount to $1,000,000, or approximately ~~£200,000.~~ £ 100,000

It is assumed in this estimate that the whole of the coal tar will be sold in the crude state. Part of the production will be converted into further and finer products, which will considerably increase the actual profits.

The total profits from the By-Product Plant will therefore be:—

Sulphate of Ammonia ...	$545,000	or	~~£109,000~~	£ 54,500
Benzol	450,000	,,	~~90,000~~	45,000
Coal Tar	1,000,000	,,	~~200,000~~	100,000
Total ...	$1,995,000	or	~~£399,000~~	£ 199,500

Coke.—The cost of production of coke will be $6·90 per ton, and the total cost of the coke produced per annum will therefore be $2,415,000.

Supposing the profits from the sale of by-products be put against the cost of production of coke, the cost of the latter will be $410,000 per annum, or, say $1·20 per ton.

The selling price of coke may be taken at $15 per ton. Taking handling charges and export duty at $1 per ton, the cost of coke f.o.b. Chinwangtao will be $2·20 per ton, and the profit $12·80 per ton, giving a total annual profit on coke sold, 60,000 tons, of $768,000, or ~~£153,600.~~ £76.800

As however, the profits from the present sales of coke made from the existing primitive ovens may be taken at $8 per ton, the extra capital expenditure now proposed on modern ovens will only increase the profits by the difference in cost of production, namely, $6·98—$1·20 = $5·78 per ton. On this basis the direct profit accruing from the new capital expenditure will amount to $346,800, or ~~£69,360.~~ £34,680

Blast Furnaces.—The furnaces will have an output of approximately 175,000 tons of pig iron per annum.

The cost of the production, including all charges, will be $15·50 per ton.

The export selling price in England of iron of a similar quality to that we shall produce, is at present £13 10s. 0d. per ton. Adding freight and import duty and other charges, we may consider the equivalent price in China at £20 per ton. It is likely that this price may be lowered in the future, and for the purpose of this estimate we will take the price which our iron will sell for, at £12, or $60 per ton. Deducting cost of production, the net profit will be $44·50 per ton, or, for the year, $7,787,500, equivalent at the current rate of exchange to ~~£1,557,500.~~ £778.750 From this net profit must be deducted 25%, payable to the Pao Hsing Iron Mining Company, as their share, under agreement, thus leaving a net return for the Administration's vested interests of $5,840,625 or £1,~~168,125.~~ £584.063

5 $

SUMMARY OF PROFITS.

The profits from the new scheme will therefore be as follows :—

Coke ovens	$346,800	or	~~£69,360~~	£34.680
Blast furnaces ...	5,840,625	or	~~1,168,125~~	584.063
	$6,187,425	or	~~£1,237,485~~	618,743
			£1.998,125	

The total estimate of costs has been given as ~~£2,500,000~~ so that it may be expected that the expenditure will be covered in a little over two years of working.

DIVISION AND LOCATION OF EXPENDITURE.

In order to facilitate financial arrangements, I will proceed to give an estimate of the expenditure in Europe or America, and China :—

General Expenditure.

	In Europe or America. £	In China. £	$	
1. Preparation of site ...		~~20,000~~ 16,250	100.000 50.000	
2. General offices		~~10,000~~		
3. Laboratory		~~4,000~~ 2.000	20.000	
4. Bungalows and coolie lines		~~27,000~~ 13,500	135.000	
5. Workshops		~~10,000~~ 5.000	50.000	
6. Roads		~~4,000~~ 2.000	20.000	
7. Lighting	5,000	~~5,000~~ 2.500	25.000	
8. Stores		~~6,000~~ 3.000	30.000	
9. Railway from subway to hills	35,000	~~25,000~~ 12.500	125.000	(Deducting proportion debitable to new works other than Chinwangtao.)
10. 36 thirty-ton cars ...	50,000	~~4,000~~ 2.000	20.000	
11. 4 locomotives	40,000	~~4,000~~ 2.000	20.000	
12. Railways from junction to various plants	45,000	~~20,000~~ 10.000	100.000	
13. Ten-ton locomotive crane ...	12,000			
14. Main Transmission Line ...		~~10,000~~ 5.000	50.000	
15. Stone crusher and mortar mills	3,500	~~500~~ 250	2,500	
16. Water supply	20,000	~~12,500~~ 6.250	62,500	
17. Power plant	125,000	~~15,000~~ 7.500	75.000	(Deducting proportion debitable to new works Chinwangtao.)
Total ...	£335,500	£ 88.500 ~~£177,000~~	$ ~~885.000~~	

Washing Plant.

	£	£	$
1. Filling		~~12,000~~ 6.000	60,000
2. Railway tracks	21,000	~~5,400~~ 2.700	27,000
3. Draper plant	15,250		
4. Minerals Separation plant	4,000		
5. Material in China ...		~~5,000~~ 2.500	25,000
6. Dryers and accessories ...	10,000		
7. Buildings and bunkers ...		~~15,000~~ 7.500	75,000
8. Water supply		~~10,000~~ 5.000	50,000
9. Electrical equipment ...	8,000		
10. Laboratory, office and stores		~~5,000~~ 2.500	25,000
11. Freight and duty ...	2,000	~~3,000~~ 1.500	15,000
Total ...	£60,250	£ 27.700 ~~£55,400~~	$ 277,000

Coke Oven Plant—Including By-Product Plant.

	In Europe or America. £	In China. £	In China. $
1. Cost of plant	280,000	~~95,000~~ 47,500	475,000
2. Salaries		~~20,000~~ 10,000	100,000
3. Freight and duty ...	24,000	~~11,000~~ 5,500	55,000
4. Offices		~~1,000~~ 500	5,000
5. Rest room for Chinese ...		~~2,000~~ 1,000	10,000
6. Refractories		~~45,000~~ 22,500	225,000
7. Stores		~~1,000~~ 500	5,000
8. Foundations		~~20,000~~ 10,000	100,000
9. Spares	15,000		
10. Special trucks	7,000		
Total...	£326,000	~~£195,000~~ 97,500	$ 975,000

Sulphuric Acid Plant.

	£	£	$
1. Cost of plant	27,000	~~16,000~~ 8,000	80.000
2. Freight and duty	3,000	~~1,000~~ 500	5.000
3. Foundations		~~3,000~~ 1,500	15.000
4. Contractors' fees ...	6,000		
5. Salaries		~~4,000~~ 2,000	20,000
6. Electrical equipment ...	1,000		
7. Stores and sulphuric acid		~~4,000~~ 2,000	20.000
Total ...	£37,000	~~£28,000~~ 14,000	140.00

Blast Furnace Plant.

	£	£	$
1. Ore stock gantry and bunkers		~~55,000~~ 27,500	275,000
2. Steelwork for furnaces, stoves, etc.	200,000	~~105,000~~ 52,500	525.000
3. Refractories	7,000	~~83,000~~ 41,500	415,000
4. Dry dust cleaner ...	30,000		
5. Blowing engines	125,000	~~30,000~~ 15,000	150,000
6. Foundations		~~50,000~~ 25,000	250.000
7. Office		~~1,000~~ 500	5,000
8. Stores		~~1,000~~ 500	5,000
9. Metal ladles	11,000		
10. Slag ladles	16,000		
11. Tools and spares ...	20,000		
12. Salaries		~~7,000~~ 3,500	35.000
13. Trucks for ore and limestone	20,000		
14. Ore crushing plant ...	10,000	~~30,000~~ 15,000	150,000
15. Freight	58,500		
16. Duty		~~22,000~~ 11,000	110.000
17. Water tower		~~15,000~~ 7,500	75.000
18. Buildings		~~35,000~~ 17,500	175.000
Total...	£497,500	~~£434,000~~ 217,000	2,170,000

This will be required to be expended in the proportion, £80,000 in England and £60,000 in China.

The résumé of the location of expenditure will therefore be :–

	In Europe or America. £	In China. £	$
1. General expenditure	335,500	~~177,000~~ 88,500	885.000
2. Washing plant	60,250	~~55,400~~ 27,700	277.000
3. Coke oven plant	326,000	~~195,000~~ 97,500	975.000
4. Sulphuric acid plant	37,000	~~28,000~~ 14,000	140.000
5. Blast furnace plant	497,500	~~434,000~~ 217,000	2,170,000
6. Additions and alterations to brick works	80,000	~~60,000~~ 30,000	300.000
Total	£1,336,250	~~£949,400~~ 474,700	4.747,000
Add: Engineers' fees and contingencies	160,000	~~54,350~~ 27,175	271,750
	£1,496,250	~~1,003,750~~ 501,875	5,018,750
	~~£1,003,750~~ 501 875		
Grand Total	~~£2,500,000~~ 1.998125		

PERIOD OVER WHICH PAYMENTS WILL BE REQUIRED.

An estimate of the dates of expenditure, under present circumstances, is extremely difficult to give.

I will suppose for the purposes of this estimate that no orders are placed before the financial year 1921-22, omitting the small expenditure already incurred on preliminary expenses and washing plant material. I will assume that at the beginning of the financial year 1921-22 all orders for machinery and plant are placed.

It seems likely that deliveries of machinery and plant therefore will commence in January, 1922, and that these deliveries will be completed during the year, probably in fairly regular instalments, but more in the months April-July. The whole of the material required should be delivered before the end of December, 1922, and all payments made except those deferred as guarantees for the good execution of the work. Certain payments will be made when the orders are placed in the beginning of the financial year 1921-22.

It will be necessary to construct the railway line from the hills near Tangho to the works and to the harbour as early as possible, in order to facilitate the commencement of the harbour development scheme. The ~~£60,000~~ £47,500 debitable to the new plant will therefore be required at an early date, say, March, 1921. The expenditure on the washing plant, in Europe and China, will also be incurred before the receipt of material from Europe.

I give below my estimate of the requirement of funds for the various undertakings :—

General Expenditure.—The total required is £335,000 in Europe and £177,000 in China.

All the items under this heading are in the nature of preliminary expenses.

The Railway to the Hills will have to be carried out immediately, with the rolling stock for the traffic to be carried, as this is necessary for the starting of work on the increase of Harbour accommodation. It will be necessary to place the order for this plant at once and the orders for the remainder of the items must be placed as soon as the definite financial arrangements are made. It will therefore be necessary to provide for the expenditure of £35,000 in Europe and £25,000 in China in January, and, supposing orders for the plant are placed in June, 1921, the whole of the rest of the items under this head must be provided for as from this date.

The general expenditure should therefore be considered as incurred as follows :—

RAILWAY FROM SUBWAY TO HILLS.

	In Europe. £	In China. £	$
January, 1921	35,000	25,000	125.000
June, 1921	80,000	310,500	1.552,500
Balance of work to be carried out in China, December, 1921	62,000		
Total ...	£177,000	£335,500	$ 1.677,500

Washing Plant.—The expenditure in connection with the small plant has either been already incurred or will be incurred in the early part of next year. The erection in China will take a considerable time and the full expenditure on it will not be paid till the latter part of the year. I consider it desirable, however, to allocate the period of expenditure as follows :—

	In Europe. £	In China. £	$
January, 1921	40,250	15,000	75,000
June, 1921	20,000	40,400	202,000
Totals	£60,250	£55,400	277.000

Coke Oven Plant.—This estimate cannot be accurately determined until the question of payment for the plant is settled with Contractors.

I think it safer to assume that 40 per cent. of the contract price will be paid at the time of placing the order, the balance being paid 40 per cent. on delivery of material, f.o.b. port of shipment, 10 per cent. on placing of material on site and 10 per cent. after the plant has been working for say three months. The expenditure in China will approximately be covered in the same periods.

Based on the above main lines, the period at which funds will be required, assuming orders to be placed in June, 1921, will be as follows :—

	In Europe. £	In China. £	$
June, 1921	127,000	47,000	235,000
June, 1922	143,000	120,000	600,000
December, 1922	56,000	28,000	140,000
Totals	£326,000	£195,000	$ 975,000

Sulphuric Acid Plant.—The expenditure on this plant will be incurred simultaneously with that on the coke oven plant, and funds will be required as follows :—

	In Europe. £	In China. £	$
June, 1921	14,800	11,200	56,000
June, 1922	14,800	11,200	56,000
December, 1922	7,400	5,600	28,000
Totals	£37,000	£28,000	$ 140,000

Blast Furnaces.—Assuming the orders for the blast furnaces to be placed at the same time as the coke ovens (June, 1921) and the payments to be incurred in the same periods, provision will have to be made as follows :—

	In Europe. £	In China. £	$
June, 1921	199,000	173,600	868,000
June, 1922	199,000	173,600	868,000
December, 1922	99,500	86,800	434,000
Totals	£497,500	£434,000	$ 2,170,000

Additions and Alterations to Brickworks.—These works will be required to be completed as early as possible after the decision is made to place the orders for the other plant.

If the orders are placed in June, 1921, I expect that 75 per cent. will be completed in the first year and 25 per cent. in the second.

It will therefore be necessary to provide funds as follows :—

	In Europe. £	In China. £	$
June, 1921	60,000	45,000	225,000
June, 1922	20,000	15,000	75,000
Totals	£80,000	£60,000	$ 300,000

Taking engineers' fees and contingencies to be spread evenly over the whole period, the requirements will be :—

	In Europe. £	In China. £	$
June, 1921	50,000	18,000	90,000
June, 1922	50,000	18,000	90,000
December, 1922	60,000	18,350	91,750
Totals	£160,000	£54,350	$ 271,750

Vº.	A	B	C	D	Total
		$	$	$	$
1	175,000	400,000	-	-	575,000
2	75,000	202,000	-	-	277,000
3	-	235,000	600.000	140.000	975.000
4	-	56,000	56,000	28.000	140.000
5	-	868,000	868,000	434,000	2,170,000
6	-	225,000	75.000		300,000
7	-	90.000	90.000	91.750	271.750
				E	310.000
#	250,000	2,076,000	1,689,000	693,750	5,018.750

SUMMARY GIVING DATES AT WHICH PROVISION OF FUNDS WILL BE NECESSARY.

	January, 1922		June, 1922		December, 1922		June, 1923		December, 1923		Totals.
	In Europe.	In China. A	In Europe.	In China. B	In Europe.	In China. E	In Europe.	In China. C	In Europe.	In China. D	
	£	£	£	£	£	£	£	£	£	£	£
1 General Expenditure	~~35,000~~ 25,000	~~25,000~~ 17,500	~~80,000~~ 310,500	~~310,500~~ 40,000	~~62,000~~	31,200	—	—	—	—	~~512,500~~ 424,000
2 Washing Plant	40,250	~~15,000~~ 7,500	20,000	~~40,100~~ 20,200	—	—	—	—	—	—	~~115,650~~ 87,950
3 Coke Ovens	—	—	127,000	~~47,000~~ 23,500	—	—	143,000	~~120,000~~ 60,000	56,000	~~28,000~~ 14,000	~~321,000~~ 423,500
4 Sulphuric Acid Plant	—	—	14,800	~~11,200~~ 5,600	—	—	14,800	~~11,200~~ 5,600	7,400	~~5,600~~ 2,800	~~65,000~~ 51,000
5 Blast Furnaces	—	—	199,000	~~173,600~~ 86,800	—	—	199,000	~~173,600~~ 86,800	99,500	~~86,800~~ 43,400	~~931,500~~ 741,500
6 Brickworks	—	—	60,000	~~45,000~~ 22,500	—	—	20,000	~~15,000~~ 7,500	—	—	~~140,000~~ 110,000
7 Engineers' Fees and Contingencies	—	—	50,000	~~18,000~~ 9,000	—	—	50,000	~~18,000~~ 9,000	60,000	~~18,350~~ 9,175	~~214,350~~ 187,175
Totals	~~£75,250~~ 65,250	~~£40,000~~ 25,000	~~£550,800~~ 781,300	~~£645,700~~ 207,600	~~£62,000~~	31,200	£426,800	~~£337,800~~ 168,900	£222,900	~~£138,750~~ 69,375	~~£2,500,000~~ 1998,125

FUNDS TO BE PROVIDED WILL BE:

		£	
In Europe—			
	January, 1922	~~75,250~~	65,250
	June, 1922	~~550,800~~	781,300
	December, 1922	~~62,000~~	
	June, 1923	426,800	
	December, 1923	222,900	
In China—			
	January, 1922	~~40,000~~	25,000
	June, 1922	~~645,700~~	207,600
	June, 1923	~~337,800~~	165,900 ---- Dec² 1922 -- 31,000
	December, 1923	~~138,750~~	69,375

The above figures have been arrived at on a definite programme for carrying out the works. It is impossible to give an accurate forecast of expenditure; all that can be done is to give an idea of the earliest dates on which funds will be needed and for which provision should be made. In round figures I think we can ignore the smaller sums and divide up the requirements into three periods and consider that the scheme has to be financed at three different dates, leaving details to work themselves out at a later date. Working on this basis, I consider it desirable that provision should be made as follows :—

	In England.	In China.	Total.
30th June, 1921 ...	£700,000	£700,000	£1,400,000
30th June, 1922 ...	500,000	300,000	800,000
31st Dec., 1923 ...	200,000	100,000	300,000
	£1,400,000	£1,100,000	£2,500,000

The actual expenditure will undoubtedly be incurred over a longer period, but I consider that it is desirable to provide funds somewhat in advance of the actual requirements.

GENERAL REMARKS.

I think it has been clearly proved from the above figures that financial success is assured, even without the future extensions proposed.

If, with a plant costing £2,500,000, a revenue based on very conservative estimates of nearly one and a quarter millions per annum can be derived, surely, even though the ore body available remains at the 4,000,000 tons of the Pao Hsing deposit, estimated sufficient to continue the works on the same scale for a period of fifteen years, the profits obtainable would be well worth the expenditure incurred. Added to this, it must be remembered that the expenditure on the washing plant is necessary to maintain our present trade, that the coke ovens would be built in any event, as they are necessary for the proper development of our trade, and in themselves will be a very large source of profit. It will be seen that the only fraction of the plant which may be said to be entirely new to our existing business, is the iron works, costing, in round figures, £1,250,000.

It has been suggested that, when we are short of coal for our present market, it is a mistake to instal works increasing the consumption of coal.

In reply to this criticism, I would point out that the coal used will be dust coal only, which, up till quite recently, it has been found difficult to sell in a sufficient proportion compared with the lump coal, so much more dust being turned out than lump. Recently, it is true, this has not been the case, but it must be remembered that steps are now being taken to nearly double our output, and this will be effected as soon as the new works are completed.

I am convinced that, under these circumstances, it will be found very advantageous to be able to use 1,400 tons of dust coal a day, thus providing a large supply of lump coal, which can always be sold at a very good profit. Were these 1,400 tons not utilized as it is proposed to in the new scheme, it would probably mean a reduction of the total output to avoid over production of dust coal, and consequent loss of profit on a considerable daily output of lump coal.

Financially, therefore, not only is there the profit on the scheme itself, but also an indirect advantage in the greater facility and greater profits obtainable from our ordinary coal sales.

It has been suggested that the profits from the direct sale of the coal might be more advantageous than spending such a large sum on capital works. The arguments employed above are alone sufficient to show the fallacy of this suggestion. Even were these not, the profits on 1,400 tons of coal per day, while we cannot reckon on getting more than $2 per ton, would amount in all to approximately £200,000 per annum, about one-half of the profits obtained from the by-product plant alone.

It must also be remembered that a considerable proportion of the coal sent to the coke ovens will only replace what is now sent to the Chinese ovens, and cannot be considered as an increase in consumption.

This Report has been made out after exhaustive studies of the whole question, particularly as regards technical detail. I regret its length, but have considered it desirable to place on record for the future all the main points considered in preparing the scheme, without too much technical detail.

W. S. NATHAN,

General Manager,

KAILAN MINING ADMINISTRATION.

22nd December, 1920.

APPENDIX.

Chemical Laboratory,
1, Arundel Street,
Strand, W.C. 2.
Sept. 11*th*, 1920.

Messrs. The Chinese Engineering and Mining Co.,
Sanctuary House,
33, Tothill Street, S.W. 1.

Dear Sirs,

KAILAN MINING ADMINISTRATION COALS.

I beg herewith to present my report upon the samples of the above coals sent to me, especially with regard to their suitability for low-temperature carbonisation.

The samples first received were labelled as follows.—

(1) No. 3 Chaokochwang Slack.
(2) Linsi 9-seam Slack.
(3) Linsi 11-seam Slack.

These three coals were all sampled down to small bulk, and both the proximate and ultimate analysis of each made. The results of the tests are given in Table I., in which the figures are made out (*a*) in percentages on the coal as received, and (*b*) as percentages of the actual coal-substance in the coals, *i.e.*, on coal less moisture and ash. For comparison, the figures are also given of an analysis made in exactly the same manner with a sample of a well-known Durham gas coal (Holmside).

The relative coking powers of the coals were ascertained by determining the number of parts of powdered anthracite with which they could be mixed without entirely losing their power of forming a coherent coke on strongly heating, the number of parts of anthracite thus found giving the "coking-index," which, save in exceptional cases, rarely exceed 15 or 16 with the best coking coals, and is, of course, *nil* with non-caking coals.

Apart from the high percentage of ash in both samples of the Linsi coals, the analysis indicates that both of these are of very high coking quality, and correspond fairly closely in composition with Durham gas coal and coking coal. The two Linsi seams differ from one another little, save in the percentage of ash, the analysis of the "coal-substance" in each not differing more than is often the case with coal from different parts of the same seam. The coals have, as would be expected from the analysis, a very high coking index, quite comparable with the Durham gas and coking coals, which are themselves the best English coke-producing coals.

The Chaokochwang No. 3 slack, apart from its high percentage of ash, is also of good quality, though it does not correspond in composition with any English coal that I have analysed. As will be seen, it has nearly as high a coking index as the Linsi coals, which would not have been anticipated from the analytical figures, as these show that the coal-substance contains 12·6 per cent. of oxygen. Almost all English coals, when they contain so high a percentage of oxygen as this, are either non-coking, or at most only feebly coking, whereas the Chaokochwang coals has a high coking index only just inferior to that of good Durham coal.

The analytical figures, so far as they go, indicate that the Linsi coals in particular, and to a lesser extent the Chaokochwang coal, are among those which are not very well suited for low-temperature carbonisation, and preliminary small scale tests with the sample at temperatures of 500-600° C. confirmed this in the case of the Linsi coals and left the matter doubtful in the case of the Chaokochwang coal. It was felt that more definite information could be obtained by having larger samples of the coal, and subjecting both not only to small scale low-temperature distillation, but also to larger scale tests under gas-making conditions in a gas-works test-plant at high temperatures, as the results obtained under the latter conditions permit of many conclusions being drawn as to their suitability for low-temperature carbonisation.

Accordingly five further samples were sent me labelled as follows :—

(1) Chaokochwang, Special Slack.
(2) ,, Ordinary Slack.
(3) ,, Washing Plant Slack.
(4) ,, 11-seam Slack.
(5) Linsi, 9-seam Slack.

All five samples were carbonised at 1,000°C. in fireclay retorts holding 14 lbs. of coal, and the yield of gas and its calorific power determined, and a complete analysis of the gas made, giving the percentage of each constituent, and the number of cubic feet of each made per ton of coal. The yield of coke at this temperature was also ascertained.

The results are tabulated in Table II., a similar test with the Durham gas coal (Holmside) made in the same apparatus being given for comparison. In this table also the results are given (*a*) on the coal as received, and (*b*) on the coal-substance, excluding ash and moisture.

The tar and the virgin ammoniacal liquor separating in the condensers in the cooling of the hot gas to atmospheric temperature were also collected and their respective quantities measured; but these last figures can only be taken as approximate, exact estimations of these not being possible in the test plant, owing to varying amounts of liquid " holding up " in the condenser and not draining uniformly each time. An estimate of the total yield of ammonia cannot be made with this plant.

The Chaokochwang coals, in all four samples, required about the same time for complete carbonisation at 1,000° C. as the Durham gas coals, and the gas results from all four, although they differ from each other to a small extent, do not vary more than is often the case with samples of coal taken from different parts of the same seam, and it may be concluded that the *coal substance* in Nos. 1, 2 and 3 is very much the same. No. 4, the Chaokochwang 11-seam slack, whilst giving very similar gas-results, yields a larger amount of tar, and this sample also shows correspondingly a rather higher percentage of volatile matter in the coal.

Compared with the Durham coals, the Chaokochwang coals gave considerably higher amounts of carbonic acid, carbonic oxide and water condensed from the gas on cooling, than the Durham gas coal, a result which would be expected in view of the much higher percentage of oxygen in the Chaokochwang. The yield of methane is somewhat and that of hydrogen considerably lower than with the Durham coal. The average yield of gas, in B.Th.U. per ton, is about 7½ per cent. lower for the coal substance of the Chaokochwang coals than with the coal-substance of the Durham gas coal.

The Linsi coal requires much longer for completion of carbonisation at 1,000° than the Durham coal, and the latter are the slowest English carbonising coals. It is indeed the slowest carbonising coal I have ever tested, requiring at least 25 per cent. longer than the Durham coals, and the rate of gas evolution is very slow throughout the whole period. The total gas yield per ton of coal-substance is only about 76 per cent. of that from the Durham coal. The yield of methane is only about 80 per cent. of that from the Durham coal, and that of hydrogen exceedingly low, being only about half of that from the Durham coal.

LOW-TEMPERATURE CARBONISATION OF THESE COALS.

To obtain direct evidence to corroborate conclusions which may be drawn from the analysis of these coals, and from their behaviour when carbonised at high temperatures, small scale laboratory tests were made with the Chaokochwang 11-seam and Linsi 9-seam coals. In these tests the coals were carbonised in small iron retorts at a temperature of about 550°C. inside the muffle in which the retorts were placed. The crude oil and gas evolved were collected and measured, and the weight of the residual low-temperature coke taken and the percentage of volatile matter left in it also determined. The results of these tests are given in Table III.

Both coals yield a low-temperature coke of good appearance, and fairly hard as compared with low-temperature cokes generally. The material still contains 12-13 per cent. of volatile matter, and apart from the high percentage of ash, due to the high ash in the original coals, both the product from the Linsi and from the Chaokochwang coal would form a good smokeless fuel.

In this respect, therefore, the coals may be said to be suitable for low-temperature carbonisation, but in all other respects they are at a decided disadvantage, this being especially the case with the Linsi coal. I do not think that this coal, in any case, is a practicable one for employment for the purpose.

The reasons for this unsuitability lie partly in the chemical properties of the substances of which the coal is composed and partly in its physical properties. The chemical properties are such that the coal substance requires for its decomposition, a decidedly higher temperature than any which are within the limits commonly described as "low" temperature for carbonisation,, and consequently the yields both of crude-oil and of gas at temperatures of 500-600°C. are much lower than with the coals preferred for low-temperature carbonisation. The Linsi coal under these conditions only yields about 5·5 gallons of crude-oil, and 1,500 cubic feet of gas per ton, whereas coals usually employed for such carbonisation yield usually from 18-22 gallons of crude-oil and 3,000-4,000 cubic feet of gas per ton. The revenue obtained from the crude-oil would therefore only be small, and the gas produced in the carbonisation would probably be quite insufficient for heating the retorts and additional fuel would have to be used for this purpose. The yield of ammonia would be small, as this is the case with all coals at temperatures below 600°C.

The physical properties of the coal are such that at temperatures above 300°C. it partially melts, forming a very stiff pasty mass or dough. Whilst this property is the direct cause of the coal yielding such an excellent coke on high temperature carbonisation, it greatly increases the difficulties of low-temperature treatment, as this pasty mass is a very bad conductor of heat, which only very slowly penetrates the sticky mass. This causes the complete carbonisation in any case to take a long time, and is more markedly the case at low temperatures, as the difference between the temperature outside the retort and the mass inside is a much smaller one.

On this account the daily throughout of any type of plant would be low, under low-temperature carbonisation conditions in particular, compared with that of the classes of coal usually employed for this purpose, and this would increase both the capital cost of plant per ton carbonised per day, and also the operating costs. In addition, the coal swells very materially in carbonising, and when carbonisation at low temperatures is complete, adheres very tenaciously to the walls of the retort, as there is none of the subsequent contraction which takes place when higher temperatures are used and causes the coke to shrink somewhat and detach itself from the retort walls, rendering its discharge readily practicable.

Owing to this passage through a very stiff pasty stage and expansion in carbonisation, great difficulties will occur in the practical working of the Linsi coal at low temperatures in any plant hitherto proposed for

the purpose with which I am acquainted. Its pasty nature at temperatures above 300°C. would render its use quite impracticable in any continuous plant where it has to be uniformly passed through a heated retort by mechanical means, as, for example, in the del Monte retort. This would also be the case in installations of the Maclaurin type, where the low temperature decomposition of the coal is effected by the internal heating obtained by the passage of hot gases through it, as the pasty mass first formed will prevent these hot gases coming in proper contact with the mass, and make its complete carbonisation almost impracticable.

The most suitable plant for this type of coal is an intermittent retort in which the coal is carbonised in thin layers, such, for example, as the Tozer retort, but even in these, very great difficulty will, in my opinion, occur in getting the proper discharge of the coke from these narrow retorts, owing to the expansion and adherence of the coke to the retort surfaces.

From all these considerations therefore, I think that the Linsi coal is one which is entirely unsuited for the purpose of low temperature carbonisation.

The Chaokochwang Coal is subject to the same objections in its use for the low temperature process as the Linsi coal, but to a decidedly less degree. Whilst it carbonises more slowly than the coals preferred for such carbonisation, it is much more rapid than the Linsi coal, and the yield of crude-oil and gas amounts to about two-thirds of that from suitable coals, compared with less than one-half in the case of the Linsi coal. It would, however, in my opinion, be quite impracticable for use in plants of the del Monte or Maclaurin type, and most suited to plants of the Tozer type, although even here considerable difficulties in obtaining the ready discharge of the coke from the retorts may be anticipated. There is therefore some possibility that, if there is a sufficient margin between the cost of the coal charged into the retorts and the selling price of the low temperature coke obtained, the Chaokochwang coal might be employed for low-temperature carbonisation under Chinese conditions with success.

Before, however, it was finally decided to erect such a plant, it would be absolutely essential that a test with the coal should be carried out on a good scale in the plant which it was proposed to adopt. Without such a test it would be impossible to be reasonably sure that the plant would work successfully with this coal.

ALTERNATIVE POSSIBILITY FOR PRODUCTION OF SMOKELESS FUEL FROM THESE COALS.

Having regard to the chemical and physical properties of these particular Chinese coals, an alternative possibility for the production of smokeless fuel from them is worth consideration. From the analytical and other results given above, it seems not at all unlikely that a suitable fuel might be obtained by carbonising them at temperatures which

would not be admitted as "low" by low-temperature carbonisation advocates, but at such which are lower than those now commonly employed in gas works practice, say about 800-850° C. In this way a coke would be obtained still containing some 5-6 per cent. of volatile matter, with a much higher rate of carbonisation and consequent reduction in working costs.

There would also be a much higher yield of ammonia, probably 20-25 lbs. of sulphate of ammonia per ton, and the production of about $1\frac{1}{2}$ gallons of crude benzol per ton. The gas yield, after stripping, would, in the case of the Chaokochwang coals, at any rate, be more than sufficient for the heating of the retorts, and to yield some surplus gas. The crude oil obtained under these conditions from the Chaokochwang coals would probably be about 10 gallons, as compared with $12\frac{1}{2}$ gallons at low temperatures, and it would probably be of lower value per gallon the latter, as it would contain a higher proportion of pitch and a lower percentage of fuel oils. As a whole, this plan, in my opinion, would give much more favourable results financially than the low temperature carbonisation of these particular coals.

Whether the coke obtained at these temperatures would be suitable for use as a smokeless fuel under Chinese conditions is a matter which would require further enquiry. I think that there is a very considerable probability that this would be the case, provided that suitable measures were adopted for the cooling of the coke drawn from the retorts. The unsuitability of ordinary gas-works coke for use as smokeless fuel for domestic purposes is by no means solely due to the small amount of volatile matter left in it, but also to large extent to the usual method of cooling it by quenching with large volumes of water and thereby leaving it with a high water content as sold.

Thus the coke obtained from continuous vertical retorts, although only containing 1-2 per cent. of volatile matter, ignites much more readily and burns much more freely than coke from horizontal retorts quenched in the usual manner, as it is discharged from the retorts in a relatively cool state, and requires little or no addition of water to cool it below its ignition point. Further, even the coke from horizontal retorts worked at very high temperature, if allowed to cool in closed vessels and not quenched with water, behaves as quite a different product so far as readiness of ignition and freedom of burning are concerned.

These Chinese coals would not be suitable for carbonising in continuous vertical retorts at medium temperatures, such as 800-850°C., as coals of this type will not work satisfactorily in such retorts unless the retort walls are heated to a very high temperature, the coals otherwise sticking in the retort. I do not, however, anticipate any material difficulty in dealing with them at such temperatures in horizontal retorts, provided with charging and discharging machinery, and with suitable plant for cooling the hot coke in presence of steam and not water and absence of air. The capital cost of the horizontal retorts is less than

that of the continuous vertical retorts, though the operating costs are higher owing to the greater number of men required in the retort house.

It is also possible that the Summers continuous horizontal oven, now in course of being tried experimentally in this country, may also prove a very suitable one for production of smokeless fuel from these coals. At present, however, matters in connection with this oven are not sufficiently far advanced to permit of any definite opinion of its suitability.

I have not been able to make any actual tests with these coals at the temperature of 800-850°C., as there was not a sufficient quantity of coal remaining after completion of the other tests.

HIGH TEMPERATURE CARBONISATION OF THE CHAOKOCHWANG AND LINSI COALS.

The results of the tests made at 1,000°C. disclose certain points bearing on their use which may be also referred to.

The Linsi coal at this temperature gave a coke which was dense and hard, and apart from its high percentage of ash was of excellent quality. The Chaokochwang 11-seam coal also gave a very good coke. The other Chaokochwang coals, when carbonised as received, without crushing, gave a coke which was not so good in appearance as the others, owing to the fact that some of the lumps much higher in ash content than the average, did not coalesce with the rest of the coal on heating, and remained plainly visible. If, however, these coals are crushed before carbonising and well mixed, they also give a coke of excellent appearance and hardness, although of course of high ash content. All of the coals, provided the ash content can be reduced to a lower figure, would be excellent coals for metallurgical coke production, and the Chaokochwang coals would also be quite suitable for gas making purposes. The Linsi coal owing to its low yield of gas would not be suitable for the latter purpose.

Whilst the Linsi coal is an excellent coke-producing coal, it has certain practical disadvantages in working, arising from its slow rate of carbonisation, and small gas yield. In view of the rate of the former found in carbonising small charges at 1,000°C., I think it is most probable that this coal, especially if charged as washed slack into the ovens with 10 per cent. of water, will require at least 30 hours or more for coking in the ovens, and as the gas yield from it is low, it is very doubtful whether with this coal alone a gas surplus of more than 25 per cent. of the amount made will be obtained.

The tests indicate that for the purpose of metallurgical coke production it would be preferable to charge a mixture of the Linsi and Chaokochwang coals, rather than the Linsi coals alone, as the mixture would require less coking time and yield a larger surplus amount of gas.

Yours faithfully,

HAROLD G. COLMAN.

TABLE I.

PROXIMATE & ULTIMATE ANALYSIS OF SAMPLES OF KAILAN MINING ADMINISTRATION COALS.

Samples received labelled as follows :—

(1) No. 3 Chaokochwang Slack.
(2) Linsi 9-Seam Slack.
(3) Linsi 11-Seam Slack.

In column (4) are given the results from a good Durham Gas Coal, when analysed in the same manner, to give comparative figures.

	(1) Chaokochwang No. 3 Slack		(2) Linsi 9-Seam Slack.		(3) Linsi 11-Seam Slack.		(4) Durham Gas Coal.	
	On Coal as recd.	On Coal Subst.	On Coal as recd.	On Coal Subst.	On Coal as recd.	On Coal Subst.	On Coal as recd.	On Coal Subst.
Proximate Analysis.							(for com	parison)
Moisture	2·3%	—	1·1%	—	0·7%	—	1·5%	—
Vol. Matter ...	27·8	37·8%	24·0	29·8%	21·0	31·4%	28·7	30·8%
Fixed Carbon ...	45·8	62·2	56·7	70·2	45·7	68·6	64·3	69·2
Ash	24·1	—	18·2	—	32·6	—	5·5	—
Ultimate Analysis.								
Moisture	2·3%	—	1·1%	—	0·7%	—	1·5%	—
Carbon	58·1	78·9%	68·6	85·0%	55·7	83·5%	78·6	84·6%
Hydrogen ...	3·8	5·2	4·3	5·3	3·6	5·4	5·3	5·7
Oxygen	9·3	12·6	5·6	7·0	5·2	7·8	5·4	5·8
Nitrogen	1·0	1·4	1·2	1·5	0·9	1·4	1·5	1·6
Sulphur	1·4	1·9	1·0	1·2	1·3	1·9	2·2	2·3
Ash	24·1	—	18·2	—	32·6	—	5·5	—
Nett Hydrogen ...	2·7%	3·7%	3·6%	4·4	2·9%	4·4%	4·6%	5·0%
Coking Index	13	—	15	—	15	—	14	—

TABLE II.—CARBONISATION OF KAILAN ADMINISTRATION COALS AT HIGH TEMPERATURES.

Coal carbonised in Fireclay Retorts in 14-lb. Charges at a Temperature of 1,000° C.

SAMPLES TESTED.

(1) Chaokochwang, Special Slack ... ... Box No. 2
(2) Do. Ordinary Slack ... ... Box No 3
(3) Do. Washing Plant Slack ... ... Box No. 4
(4) Chaokochwang, 11-Seam Slack ... ... Box No. 5
(5) Linsi, 9-Seam Slack ... ... Box No. 15
(6) Durham Gas Coal (for comparison).

	(1) Chaokochwang Special Slack.		(2) Chaokochwang Ordinary Slack.		(3) Chaokochwang Washing Plant Slack.		(4) Chaokochwang 11-Seam Slack.		(5) Linsi 9-Seam Slack.		(For comparison). (6) Durham Gas Coal.	
	On Coal as Recd.	On Coal Subst.	On Coal as Recd.	On Coal Subst.	On Coal as Recd.	On Coal Subst.	On Coal as Recd.	On Coal Subst.	On Coal as Recd.	On Coal Subst.	On Coal as Recd.	On Coal Subst.
Proximate Analysis—												
Moisture	1·5%	—	1·6%	—	2·0%	—	1·5%	—	0·9%	—	1·5%	—
Volatile Matter	30·9	39·9%	28·0	37·6%	30·1	39·2%	37·3	43·4%	24·3	30·5%	28·7	30·9%
Fixed Carbon	46·5	60·1	46·4	62·4	46·7	60·8	48·6	56·6	55·5	69·5	64·3	69·1
Ash	21·1	—	24·0	—	21·2	—	12·6	—	19·3	—	5·5	—
Gas made per ton in cub. ft. at 60° F. and at 30 in. Barometer.	8,731	11,281	8,798	11,825	8,383	10,915	9,400	10,940	7,405	9,280	11,119	11,956
Gross Calorific Power in B.Th.U. per cub. ft.	552 B. Th. U.	552 B. Th. U.	544 B. Th. U.	544 B. Th. U.	537 B. Th. U.	537 B. Th. U.	597 B. Th. U.	597 B. Th. U.	556 B. Th. U.	556 B. Th. U.	565 B. Th. U.	565 B. Th. U.
Total B.Th.U. in gas from 1 ton ...	4,819,000	6,225,000	4,787,000	6,435,000	4,503,000	5,862,000	5,611,000	6,532,000	4,118,000	5,160,000	6,282,000	6,755,000
	c. ft. p. tn.	%	c. ft. p. tn.	%	c. ft. p. tn.	%	c. ft. p. tn.	%	c. ft. p. tn.	%	c. ft. p. tn.	%	c. ft. p. tn.	%	c. ft. p. tn.	%	c. ft. p. tn.	%
Composition of Gas—																		
Carbonic acid	4·4	384	4·4	496	4·8	422	4·8	567	4·9	411	4·9	535	4·8	451	4·8	525	4·2	311	4·2	390	1·2	133	1·2	143
Unsaturated Hydrocarbons ...	3·7	323	3·7	417	3·3	290	3·3	390	3·1	260	3·1	339	4·6	432	4·6	503	3·1	230	3·1	288	1·8	200	1·8	215
Oxygen	0·1	9	0·1	12	—	—	—	—	0·1	8	0·1	10	—	—	—	—	—	—	—	—	—	—	—	—
Carbonic oxide	11·3	987	11·3	1,275	10·8	950	10·8	1,277	11·3	94[illegible]	11·3	1,234	10·4	978	10·4	1,138	7·7	570	7·7	715	7·5	834	7·5	897
Methane	31·6	2,759	31·6	3,565	32·8	2,886	32·8	3,879	31·8	2,666	31·8	3,472	32·6	3,064	32·6	3,567	34·6	2,562	34·6	3,210	33·6	3,736	33·6	4,017
Hydrogen	38·4	3,353	38·4	4,332	37·2	3,273	37·2	4,400	39·8	3,336	39·8	4,343	40·6	3,817	40·6	4,443	31·5	2,332	31·5	2,923	49·5	5,504	49·5	5,918
Nitrogen	10·5	916	10·5	1,184	11·1	977	11·1	1,312	9·0	754	9·0	982	7·0	658	7·0	764	18·9	1,400	18·9	1,754	6·4	712	6·4	766
Yield of Dry Coke	69·6%	—	71·0%	—	70·0%	—	63·4%	—	76·3%	—	70·0%	—
Ash in Coke	30·5%	—	33·6%	—	30·2%	—	19·2%	—	25·1%	—	7·8%	—
Approximate Yield of Tar (gallons)	?	?	4·7 gal.	6·4 gal.	5·2 gal.	6·8 gal.	9·2 gal.	10·8 gal.	9·2 gal.	11·5 gal.	8·5 gal.	9·2 gal.
Virgin Ammoniacal Liquor (gallons)	16·5 gal.	21·8 gal.	16·5 gal.	22·2 gal.	18·0 gal.	23·5 gal.	18·7 gal.	21·3 gal.	13·0 gal.	16·2 gal.	13·0 gal.	14·0 gal.

Char K. Chwy		550°				Semi cok
11 S. abd		Semi-cok				
	1,5			0,9		
37,3	37.6	13 %		24,3	24.5	12 %
49,6	59,7	73.8		55.5	56.0	85
12,6	12,7	[illegible]		19,3	19,5	[illegible]
	100					

Moslem
V. M
C F
Ash

73,8

12,5
4,54
0 0
6 2,5
5 3 5
6,8

TABLE III.

CARBONISATION OF CHAOKOCHWANG 11-SEAM SLACK & LINSI 9-SEAM SLACK AT TEMPERATURES OF ABOUT 550°C.

	Chaokochwang 11-Seam Slack.	Linsi 9-Seam Slack.
Yield of Crude Oil per ton	12·5 galls.	5·5 galls.
Sp. gr. of Crude Oil	0·986.	0·995
Yield of Gas per ton	2,500 c. ft.	1,500 c. ft.
Yield of low temp. Coke, per cent.	73·8 %	85·0 %
Vol. matter in low temp. Coke, per cent. ...	13 %	12 %

The low-temperature coke obtained from both coals was fairly bright and black in appearance, and of a fair degree of hardness compared with low-temperature cokes in general.

The coal swelled very considerably in carbonising, the tube used as retort being only charged a little more than half full of the coal, and yet being nearly full on completion of the carbonisation at about 550°. The coke adhered very firmly to the sides of the tube and was only detached with difficulty.

With the Chaokochwang, the time for completion of carbonisation, as shown by ceasing of gas evolution was about the same as with Durham coal, the slowest carbonising English coals, and decidedly slower than Yorkshire coal under similar conditions. In the case of the Linsi coal, the carbonisation at this temperature was exceedingly slow, much slower than with Durham coals.

APPENDIX.

Copy of memorandum submitted by Mr. F. W. Harbord to the undermentioned firms in calling for tenders for the supply and erection of coke ovens, by product and sulphuric acid plants :—

Simon-Carves, Limited.
The Coppee Company (Great Britain), Limited.
The Koppers Coke Oven and By-product Company.
The Wilputte Coke Oven Corporation.
Freyn and Brassett.
The Foundation Oven Corporation.
Société Franco-Belge de Fours à Coke.

INFORMATION ON WHICH ESTIMATES SHOULD BE BASED FOR THE SUPPLY AND ERECTION OF A BY-PRODUCT RECOVERY COKING PLANT AT CHINWANGTAO, NORTH CHINA.

General Information.

The site is level but foundations are not good and piling may be necessary throughout. For the purpose of estimates, however, the foundations should be considered as on ordinary firm level ground. The permanent water level is 6 feet below the surface. The climate is hot in summer and cold in winter. The highest summer temperature is about 100° to 105° in the shade, and the lowest winter temperature is about 15°F. below Zero. There is little snow, rarely more than 2 ins. on the ground, but in certain seasons high winds prevail from N.E.

Cement, building materials and fire bricks can be obtained locally.

In making out the estimate, the f.o.b. price should be given for all materials under the heads given below, and a separate estimate for erection, based on prices of material and labour, as given. The Contractor will have to send out a reliable Engineer and such skilled men as he considers necessary and undertake to be responsible for the erection of the plant and its running, say, for six months. The Engineers and skilled men will be placed on the pay roll of the Kailan Mining Administration at a salary to be agreed upon, travelling expenses to and from China will be paid, together with an allowance for board and lodging while in China.

Prices at Chinwangtao.

Labour :—

Skilled.—Bricklayers	2/- per day—8 hours	(4 Chinese = 1 European).
Fitters and blacksmiths...	2/6 per day—8 hours	(2 Chinese = 1 European).
Unskilled.—All classes	1/4 per day—8 hours	(2 Chinese = 1 European).

Materials :—

Timber (sawn)	3/- per cubic foot
Cement	100/- per ton.
Sand	3/- „
Broken stone for aggregate	3/- „
Lime	8/- „
Ordinary building bricks "D" (common)	28/- per thousand.
Firebricks (standard) "AA" ...	65/- „ = 3·2 tons.
„ (special shapes) ...	30/- per ton.

The estimate should be for ovens to carbonize 1,400 tons of washed coal per day, *i.e.*, to produce 1,000 tons of coke, but washing plant need not be included.

Nature of coal to be carbonized.—The coal sent to the coke ovens will have the following approximate analysis :—

Moisture	8 to 10 per cent.
Volatile matter	28 „
Ash	10 to 13 „
Sulphur	1 to 1·2 „
Nitrogen	1 to 1·2 „

The coal has very strong caking and coking properties. The approximate sizing of the coal will be 0-$\frac{3}{8}$″ with a large proportion (65 per cent. to 70 per cent.) of fine below $\frac{1}{8}$″.

The following details should be given :—

Crushers.—Type, price and weight—to work 16 hours per diem. Alternatively to work only 8 hours per diem.

Coal Bunkers.—Two bunkers for coal of 1,500 tons capacity each, price, weight, etc.

Regenerative Oven (Overhead Charging).—Quantity, weight and price per ton, f.o.b., of :—

Structural steel.
Steel castings.
Iron castings.
Miscellaneous iron and steel work (rails, etc.).
Refractories—quantities, weight and price.
- Best firebricks (standard size) per ton, f.o.b.
- Best firebricks (special shapes) per ton, f.o.b.
- Bricks for regenerators, per ton, f.o.b.
- Second quality firebricks (for flues, etc.), per ton, f.o.b.

Details of costs of :—
- Charging appliance. Price per machine and weight.
- Discharging „ „ „ „
- Quenching „ „ „ „
- Handling appliance to trucks.
  - (Alternative methods may be given, with or without breeze screening) price, weight, etc.
- Boilers, motors, etc., details as to power, weight and price, f.o.b.

By-Product Recovery Plant :—

(*a*) Sulphate of ammonia, cost f.o.b. and approximate weight. (Alternative methods.)

(*b*) Tar recovery. Cost f.o.b. and approximate weight.

(*c*) Tar distillation. (Pitch toils.)

(*d*) Benzol plant. Cost f.o.b. and approximate weight.

(*e*) Rectifying plant. Cost f.o.b. and approximate weight.

(*f*) Boilers, motors, etc., f.o.b. and approximate weight.

(*g*) Gas holder. State size recommended f.o.b. cost, ready for erection and weight.

Acid Plant.—To make acid from pyrites or from sulphur recovered from the gas by means of bog iron ore, price, weight, etc.

It may be assumed that power will be supplied from a central power house and only such boiler power need be included as is necessary for steam for the process, apart from power. The question of steam exhausts as a stand-by should be allowed for.

The approximate cost of foundations, erection of plant, buildings, etc., etc., is to be based on prices of local building materials and local labour costs given above.

The total amount of power required both at ovens and by-product plant should be given; also voltage period and phase preferred.

All buildings to be substantial but plain, built of local brick.

Each individual plant should be provided with every facility for dealing with breakdown and replacement of plant by cranes or otherwise.

APPENDIX.

KAILAN MINING ADMINISTRATION.

Sanctuary House,
Tothill Street, Westminster,
London, S.W. 1,
1st November, 1920.

General Manager,

Enclosed herewith is the detailed estimate of the proposed new plant for Machiakow, and a cost price sheet of the materials needed by the proposed iron scheme at Chinwangtao.

The total amount required is £200,000, of which sum there is needed :—

For Iron Scheme.

I. Siliceous brick machinery	£89,777
II. Roofing tiles for use in lieu of galvanized iron	20,982
III. Firebricks and fireclay	28,369
	£139,128

For enlarging existing Works for current demands.

IV. Firebricks and fireclay for outside sales	£51,572
V. Extensions to plant for mines' bricks ...	9,300
	£200,000

The first three items, totalling to £139,128, are entirely for the new iron scheme; the fourth is necessary in that the Administration has no modern machinery for the manufacture of high grade firebricks, and a new factory is inevitable in any event now that the old fireclay seams at Tongshan have been exhausted ; the last item is due to the increased demand for mines' bricks. The mines will shortly require 20,000,000 bricks per annum, compared with some thirteen millions at present consumed.

The expenditure would be spread over a period of three years and would be required :—

	In Europe. £	In China. £
First Year	60,000	40,000
Second Year	30,000	20,000
Third Year	30,000	20,000

(Exchange is based on 4/- per dollar.)

The plant proposed covers the manufacture of refractories by the most approved modern methods. It is a first class plant for the outturn of the highest grade products. It is so arranged that it will meet the entire demand of the China market, and embraces sanitary pipes, hollow bricks, paving bricks and blocks, roofing tiles and facing bricks, many items of which the administration has hitherto not been able to handle solely because of the absence of suitable machinery.

The plant is divided into five units, of which one has certain special features necessary in the treatment of quartzite, but which will not nullify its being employed for the manufacture of firebricks. The other units are standardized to such a degree that they may be used at will for the manufacture of firebricks, hollow bricks, heavy paving bricks and blocks and even for mines' bricks, according to the demand of any particular time.

I may say that these proposals pre-suppose that the investigations of Dr. Mellor and others into the suitability of the quartzite will be brought to a successful conclusion. The figures of the cost of plant are based entirely on Messrs. Johnson and Company's estimates; other estimates are expected in about ten days.

Some further study is necessary respecting gas-fired kilns, but the conclusions indicated in this estimate will in all probability be followed.

W. SUTTON.

1*st November*, 1920.

ESTIMATED COST PRICES.

BASED ON:—

Minimum Output:—

Silica Set	... ...	11,000 tons per annum
Tile Set	... ...	11,000 „ „ „
Balance	... ...	46,000 „ „ „

(This is 35 % less than maximum possible output).

(*b*) *Capital Expenditure:—*

Silica	$448,975
Tiles	104,910
Firebricks	399,615
Mines bricks	46,500

(*c*) *Rent of Machiakow Works and Quarries:—*

Old Works and Quarries	$50,000
New Quarries (say)	10,000
	$60,000

(*d*) *Supervision:—*

1 Foreign Superintendent	$13,000
1 Foreign Inspector (temporary) ...	11,000
1 Practical Man	6,500
Chinese:—	
1 at $150; 13 at $80; 6 at $40	15,240
Sundry Employes	2,260
	$48,000

(*e*) *Depreciation:—*

At 5 % (first year).

(*f*) *Repairs and Maintenauce.—*

At 2½ % (first year).

	Silica. $	Tiles. $	Firebricks. $	Mines bricks. $
Rent—$60,000	6,000	6,000	24,000	24,000
Supervision—$48,000	16,000	4,800	17,600	9,600
Depreciation—$50,000	22,450	5,245	19,980	2,325
Repairs and Maintenance—$25,000	11,225	2,622	9,990	1,163
	$55,675	$18,667	$71,570	$37,088
Rate per ton—11,000 tons	$5.06	$1.70	—	—
46,000 tons	—	—	$1.56	
Haulage to Kaiping—10 cents	.10	.10	.10	See
Railage to Chinwangtao	1.25	1.25	1.25	
Labour, including fuel at cost price	8.00	4.80	4.00	ordinary
				Cost
TOTAL COST.....	$14.41 per ton.	$7.85 = $15.70 %	$6.91 per ton.	Price
N.B. Silica materials are regarded as too expensive and firebricks too cheap. The quantities required in each case are identical. Consequently, for the purposes of the Estimates, these adjustments are made ... ... less	2.00		plus 2.00	Sheet.
EXCLUDING INTEREST ON CAPITAL AND ADMINISTRATION.	$12.41		$8.91	

ESTIMATED COST OF PROPOSED NEW PLANT AT MACHIAKOW.

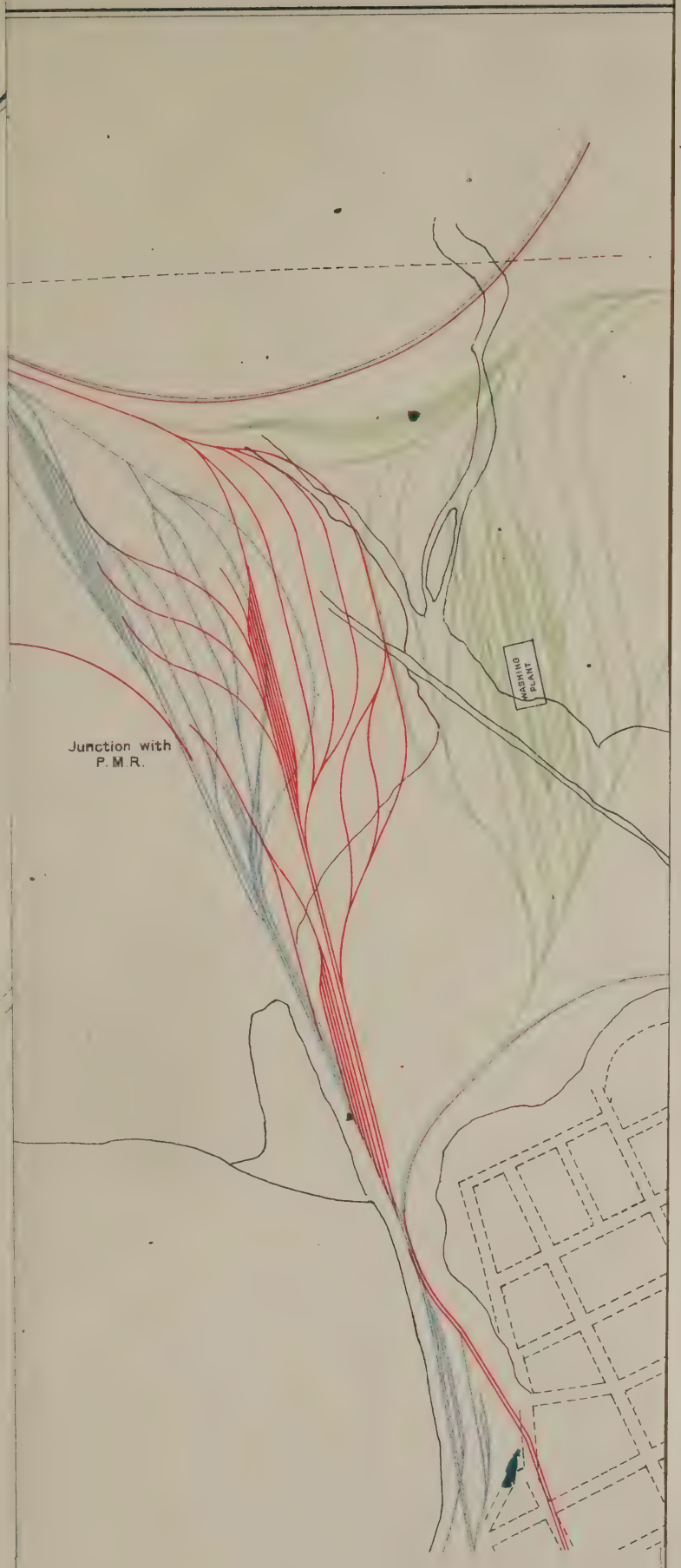
(Dollars converted to Sterling at 4/–).

		TOTAL. £	1. Silica. £	2. Tiles. £	3. Fire-bricks. £	4. Mines bricks. £
1	Research Work in Europe and America (say) £2,000.	2,000	1,500	—	500	—
2	Quartzite Quarries: 200 Mu at $20 (?) ...	800	800	—	—	—
3	Tile Clay to be purchased (say)	1,000	—	1,000	—	—
4	Power Lines (say)	500	160	80	260	—
5	Machinery and Raw Clay House—150 × 180 × av. 20 feet @ 15 cents c. ft.	16,200	4,860	1,620	9,720	—
6	*Machinery.*					
	(*a*) First Elevators £1,075 Electrical gear plus 20% 215 £1,290 Possible increase 5% ... ... 65 £1,355 Transport 15% ... 410	1,765	530	175	1,060	—
	(*b*) Silica set — £12,815 ... ... Extras as preceding item (excluding heating of machine house)	18,567	18,567 (say)	—	—	—
	(*c*) Other Plant—£40,535 ... ... Extras as before (including heating for tunnel dryer and silica set, as well as the boilers and piping for drying sheds)	58,735	8,735	11,747	38,253	—
7	*Water Supplies.*					
	Tank and a Pump (piping included in "6")...	400	120	40	240	—
8	*Cost of Erection* :—					
	1 Foreigner ... ... £2,400 50 Fitters—1 Year 2,400	4,800	1,440	480	2,880	—
9	*Transport.*					
	1,000 feet Standard gauge track, with crossings complete, and laid, 20 tons @ £35... ... ... £700 2 miles of 16 lb. track, laid—50 tons @ £30... ... ... £1,750 50 turntables (say) ... ... 100 100 tubs @ $175 3,500	6,050	2,420	1,210	2,420	—
10	*Tunnel Dryer*: (See also "6 (*c*)")					
	Materials ... ... £7,300 Add 5 to 15% ... ... 8,815 Building in China—$7,000 ... 1,400	10,215	10,215	—	—	—
11	Heated Sheds (24,000 sq. feet). (*See* also 6*c*) 4 at $7,000 each	5,600	1,120	560	3,920	—
12	Open Drying Floors, 50,000 sq. feet at $3,000	600	—	200	400	—
13	Machine Shop with equipment, say $3,000...	600	180	60	360	—
	Carried forward					

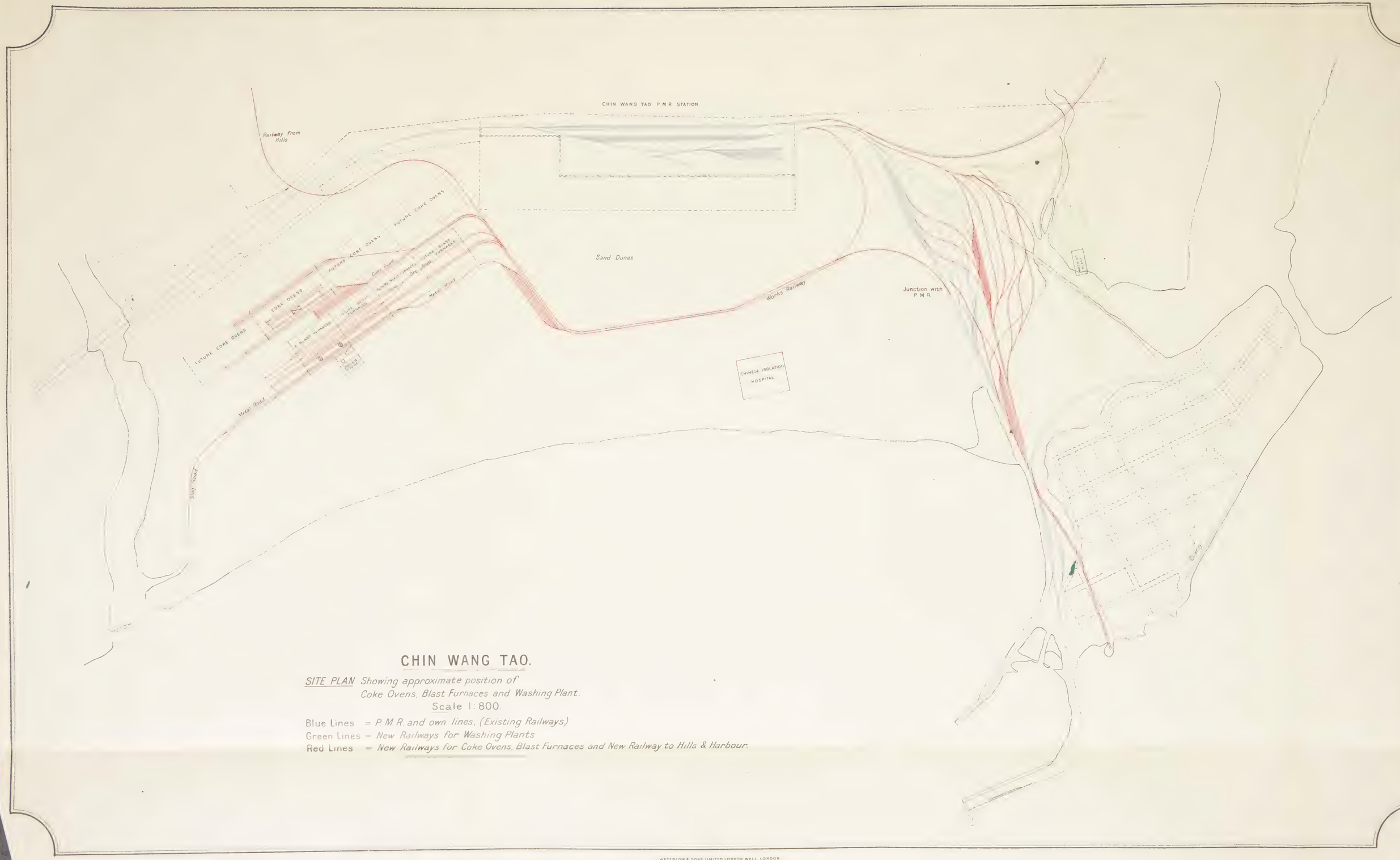
ESTIMATED COST OF PROPOSED NEW PLANT AT MACHIAKOW—*continued.*

(Dollars converted to Sterling at 4/-).

		TOTAL. £	1. Silica. £	2. Tiles. £	3. Fire-bricks. £	4. Mines bricks. £
	Brought forward					
14	Laboratory Testing Machinery & Pyrometers, say $5,000	1,000	300	100	600	—
15	Gas Producers, 5 sets at £2,200 each ...	11,000	8,800	—	2,200	—
16	Kilns, 1 Hoffman	5,000	—	—	—	5,000
	25 High temperature kilns (including Royalties) @ $6,850 each	34,250	27,400	—	6,850	—
	15 Chinese adapted kilns @ $3,000	9,000	—	2,700	6,300	—
17	Housing Foreign Staff, 2 Bungalows—$25,000	5,000	1,500	500	2,000	1,000
18	Housing Coolies, 500 men = 100 Chien @ $120	2,500	750	250	1,000	500
19	Offices—$2,500	500	150	50	200	100
20	Stores—$2,500	500	150	50	200	100
21	Wheelbarrows, drying boards, etc.—$4,000 ...	800	80	160	560	—
22	Extra Machinery for Existing Plant at Machiakow :— 1 Press, 1 Mixer, 1 Disintegrator } Complete with shafting and erection ...	2,600	—	—	—	2,600
23	Contingencies	18	—	—	—	—
	TOTAL FOR IRON SCHEME	139,128	89,777	20,982	28,369	—
	TOTAL FOR ENLARGING EXISTING WORKS FOR CURRENT REQUIREMENTS ...	60,872	—	—	51,572	9,300
	GRAND TOTAL	200,000	89,777	20,982	79,941	9,300


WASHING PLANT
Junction with P.M.R.

PLAN Nº I.



CHIN WANG TAO.

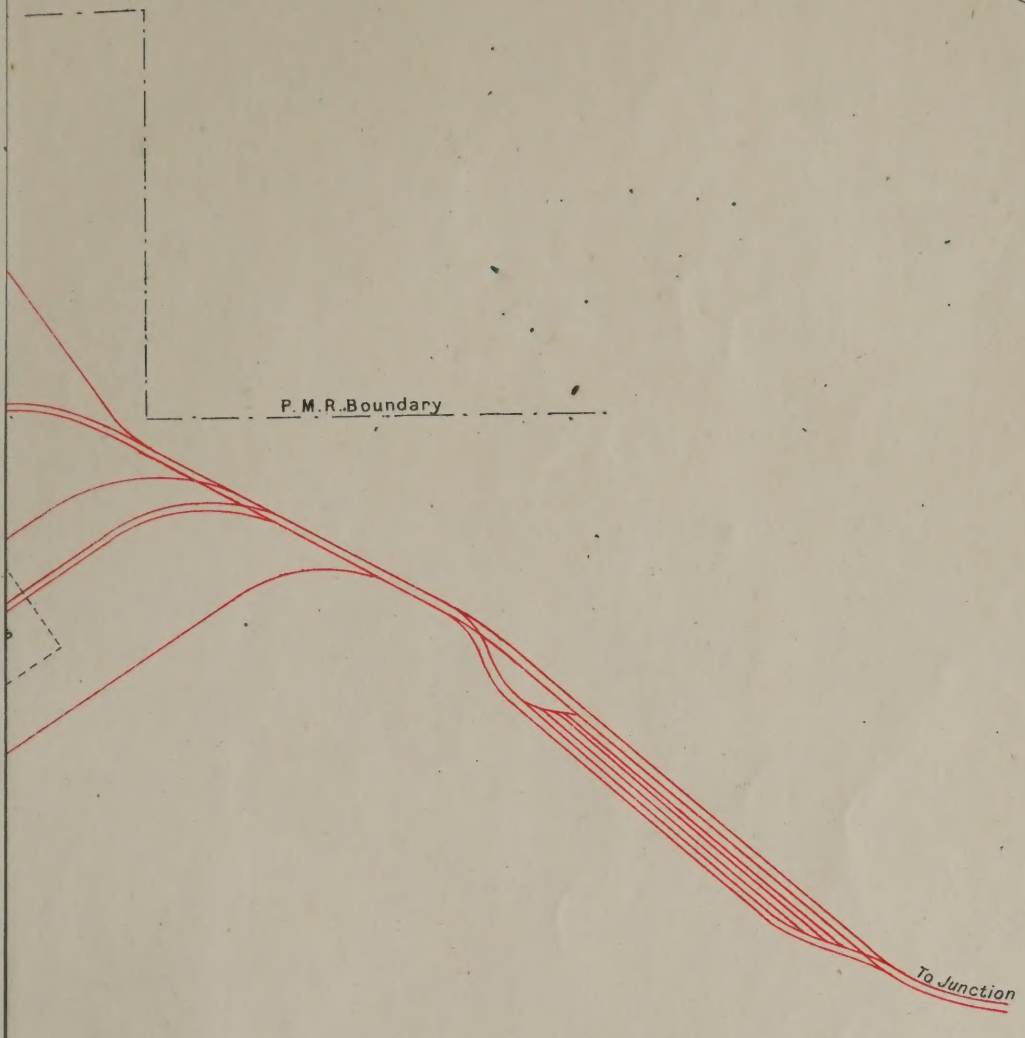
SITE PLAN *Showing approximate position of Coke Ovens, Blast Furnaces and Washing Plant.*

Scale 1:800.

Blue Lines = *P.M.R. and own lines, (Existing Railways)*
Green Lines = *New Railways for Washing Plants*
Red Lines = *New Railways for Coke Ovens, Blast Furnaces and New Railway to Hills & Harbour.*

WATERLOW & SONS LIMITED LONDON WALL LONDON

PLAN Nº 2.



PLAN No. 2.

CHIN WANG TAO.

GENERAL LAY-OUT OF

COKE OVENS & BLAST FURNACES.

— Scale, 1·400.—

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